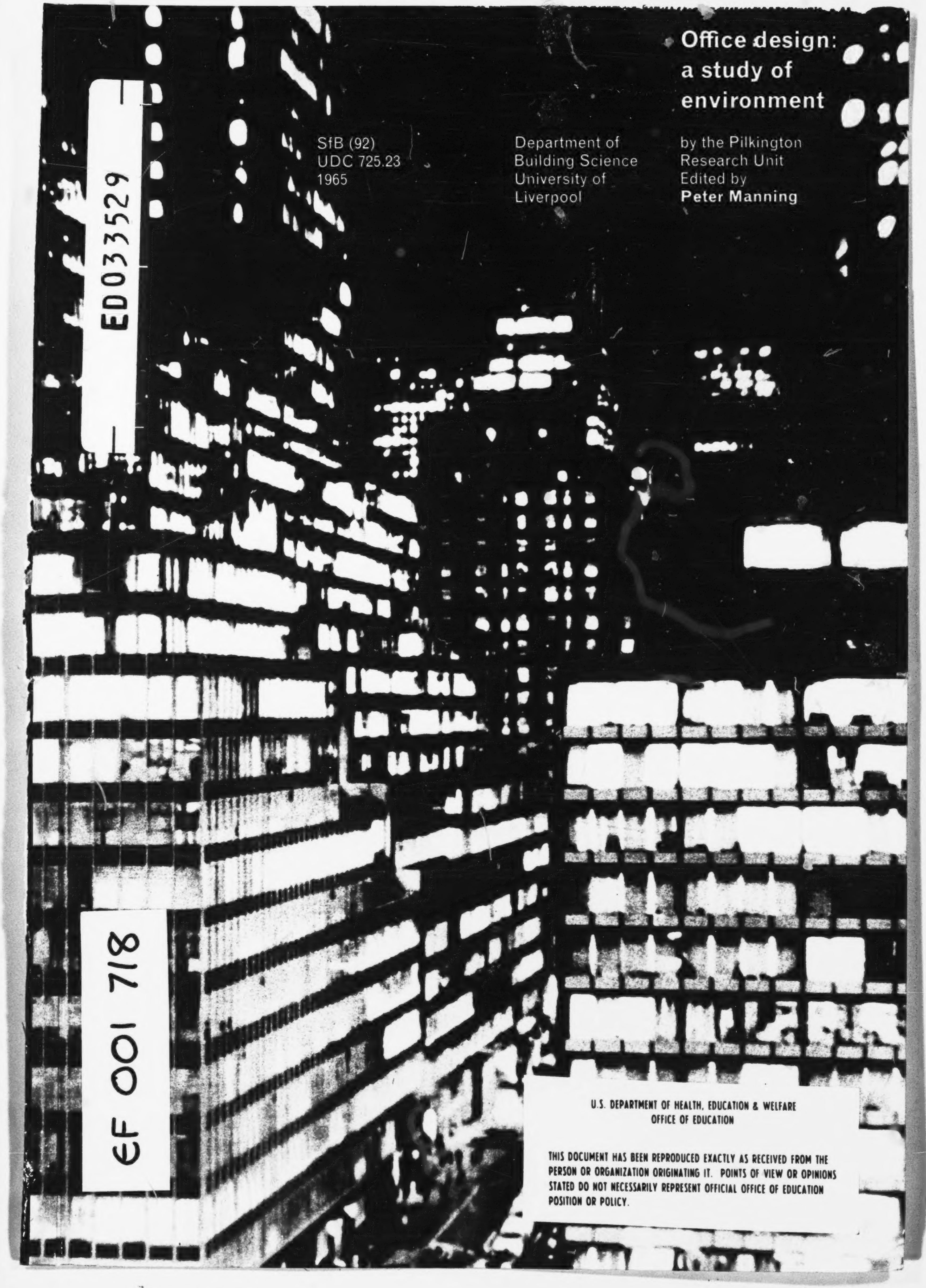
DOCUMENT RESUME

ED 033 529 EF 001 718

AUTHOR	Manning, Peter, Ed.
TITLE	Office Design: A Study of Environment.
INSTITUTION	Community Coll. Planning Center, Stanford, Calif.
Pub Date	May 65
Note	154p.; Reprinted 1966
Available from	Department of Building Science, University of Liverpool, Liverpool, England (Thirty Shillings)
EDRS Price	EDRS Price MF-$0.75 HC Not Available from EDRS.
Descriptors	Acoustical Environment, Attitudes, Building Design, Controlled Environment, Design Needs, *Environmental Criteria, *Environmental Influences, *Environmental Research, Interior Design, Interior Space, *Offices (Facilities), Physical Design Needs, Physical Environment, Psychological Design Needs, Research Criteria, Social Environment, Space Utilization, Surveys, Task Performance, Thermal Environment, Visual Environment, *Work Environment

Abstract

Reporting upon a study of environment which was based on the design of office buildings and office space, the study forms part of a continuing program of environmental research sponsored by Pilkington Brothers Limited of St. Helens, England. In this report the word 'environment' is used in the sense of the sum of the physical and emotional sensations experienced by people within buildings. The long-term aim of this research is the academic development of an understanding of this "total environment". This multi-disciplinary publication is accomplished by individual reports from the four research staff members--(1) a general survey by the architect of literature relating to office design and environment, (2) an account by the geographer of the general characteristics, population and location of post-war office buildings in England and Wales, (3) a report by the physicist of the results of surveys in offices of noise, lighting, and thermal conditions in winter and summer, and (4) a report by the psychologist of the response of the CIS (Co-operative Insurance Society, Ltd., Manchester, England) staff to their working environment and its implications for office design. Illustrations, photographs, charts, diagrams, appendices, and an index are provided. (KK)



Office design: a study of environment

SfB (92)
UDC 725.23
1965

Department of
Building Science
University of
Liverpool

by the Pilkington
Research Unit
Edited by
Peter Manning

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Synopsis

Office design: a study of environment

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This publication reports upon a study of environment which was based on the design and performance of office buildings and office space, and people's attitudes towards the offices they use. It is not strictly a research report, in the sense that the term is normally used, nor is it a design guide. Instead it sets out to provide a picture of environment 'in the round', as it is seen from the present stage of development of the Pilkington Research Unit's studies of the total environment within buildings.

The report discusses some of the major components of building environment in their physical, psychological and design aspects and endeavours to show the interrelation of one component with another. It gives an account of the present state of office design and environment, summarises current knowledge, examines and compares those environmental standards that have been established, and incorporates the Unit's own contribution to an understanding of the subjects of office design and environment.

This picture of environment is presented in four stages of increasing detail. The first, and most brief, account of the principal findings and their relevance to contemporary architecture is contained in Stage One (Foreword, written by G. Grenfell Baines). This is followed by Stage Two (Chapter One), which summarises present trends in office design and environment, and states the lessons of the project for further environmental research. Stage Three consists of a series of chapters and is in two parts. The first part commences with an introductory chapter, follows with a description of the building type and its main characteristics (including a general picture of the office buildings which have formed the 'Survey Sample' for the Unit's investigations) and continues with detailed discussions of different environmental components in isolation. These components include the location of post war office building, the spatial, visual, thermal and aural environments, and the subjective and social consequences of building environmental design. The second part of Stage Three (Chapter 10) comprises a detailed case study of the total environment within one of Britain's outstanding modern buildings. Stage Four consists of a number of appendices which describe the research methodology and tabulate the more detailed findings of the investigations.

The report is primarily addressed to other research groups engaged in systematic studies of architecture. But since it indicates an approach to office design from the basis of the environment which people working inside buildings experience, it is hoped that it will also prove of interest to office managements, their designers, and others.

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Published in 1965 by
The Pilkington Research Unit
Department of Building Science
University of Liverpool
Reprinted 1966

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Price Thirty Shillings

Book designed by Alan G. Swerdlow N.D.D.

Made and printed in England by
Rockliff Brothers Limited 44 Castle Street Liverpool 2

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**Department of Building Science
University of Liverpool**

May 1965

Stage One: Foreword

by G. Grenfell Baines, O.B.E., F.R.I.B.A., M.T.P.I.

This report aims to provide a global picture of the environment in modern office buildings, and in so doing brings a new approach to the evaluation of building performance. Though mainly exploratory, setting the pattern for further detailed studies, it consolidates existing knowledge which has been gleaned from many sources, exposing some of the gaps and filling some others. It indicates an approach to design on the basis of thinking outwards from the office worker to his workplace.

The report is compiled by the Pilkington Research Unit which developed out of the factory research project whose outcome was the book 'Design of roofs for single-storey general-purpose factories', a publication which aroused considerable and widespread interest. Since this achievement the Unit has continued to develop a multi-disciplinary structure and its approach to a better understanding of the 'total environment' within buildings. Each element of this total environment (eg, lighting, heating, ventilation, acoustics) which hitherto has been studied in isolation is now reviewed in the context of a total experience – in other words, in terms of the way in which people encounter buildings. Studies of this kind must be of fundamental importance to the development of the discipline of building design.

The Unit has evolved into a multi-disciplinary team made up of an architect, a geographer, a physicist and a psychologist. The architect, besides providing the general direction of the research, was also responsible for building design aspects of the study. The geographer was concerned with climatic and locational influences, and the physicist with measurement and description of the physical environment. The psychologist undertook studies of attitudes towards, and the social and physical influences upon, the users of buildings.

While developing the long term aim of a general understanding of total environment within buildings the Unit is basing its environmental studies on a number of building types, this on offices being the first. Other projects in hand, currently, are primary schools and mental hospitals. Besides providing a more comprehensive picture of the internal environment in particular building types (which should provide valuable material for design guidance), important information on the process of inter-disciplinary working will emerge, greatly helping the building design professions to develop more fruitful methods of work.

The present report provides the most comprehensive estimate in existence of post-war office construction and location. The interim statement on this particular topic, published in the Research Section of the *Architects' Journal*, has already been used extensively by planners and commercial research organisations. The study also demonstrates the possibilities of psychological investigation into people's response to their working conditions, and shows some of the many ways in which the environments architects create may influence human behaviour. Where other research bordering this field has been content to stop at the facts as they appear, this has delved into possible reasons for opinions and reactions to questions. The report demonstrates that many office buildings are not designed to take advantage of knowledge already available or are designed largely on the basis of assumptions made by owners and architects. It forecasts a trend to open planning, with deeper plan forms and engineered environments. Evolution in design is inevitably implied. Just as the previous factory report provided a needed stimulus for design ideas based on ascertained and correlated facts, this report should give a similar service to the design of better offices.

The work has been made possible by the generosity of Messrs. Pilkington Brothers who will support the Unit until 1967. Members of the Building Research Station, the Institute of Directors, the Liverpool School of Architecture and Department of Building Science have voluntarily given time to the committee which advises the Unit. It is hoped that the University will be in a position to take over the financial responsibility for the work in 1967.

Acknowledgements

A research project of the sort described in this book receives a vast amount of help from too many people for it to be possible to give individual thanks. But special mention must be made of the managements and staffs of the CIS and other organisations whose office buildings comprised the 'Survey Sample'. It is difficult to know why they helped us: perhaps they did not realise when they let us into their buildings for the first time that we would cause them endless trouble and sometimes expense, occupy their time, distract their staff, and ask all manner of questions, many of which must have seemed quite impertinent. Yet, having discovered what was involved, they continued to help. And without the facilities they so generously provided, these studies would have been quite impossible.

The sources of certain illustrations are acknowledged with thanks: figure 27, British Petroleum Company Ltd; figures 26, 38, 39, 73, 74, 75, 81 and the whole page plate facing page 79, Co-operative Insurance Society Ltd; figures 80, 82, 84, Design Research Unit; figure 45, E. S. and A. Robinson Ltd; figures 2, 3, 23, West Midlands Gas Board. Figures 24 and 25 are reproduced from the Japanese magazine, *Public Buildings*. Figure 28 is based on a drawing by Fergus Designs Ltd, figure 36 on one by the Staff Architect to Messrs. Robinson and figure 76 on drawings provided by the CIS. The original versions of figures 7 and 19 were first published in the *Architects' Journal*. Quotations appear by permission of the publishers or authors named in the footnote references.

With the exception of figures 24 and 25, all the line diagrams in the book were prepared by David Jeffcoate.

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Stage Two

Summary and Conclusions

Chapter 1
Summary and Conclusions

Introduction

Building in 1965 is a matter of considerable political importance receiving governmental attention on a scale previously unknown. But current interest resides largely in the ways and means of construction, especially in speed and quantity; whether what is being built is what is really needed is rarely questioned. Although environment is a word often heard when the design of modern buildings is being discussed, it tends to be employed loosely and imprecisely. Sometimes it is seen as a side-effect of design. It is rarely treated (as it is in this study) as the essential basis. Yet environment is the essence of architecture.

An ordered assembly of existing knowledge of environment in relation to building design does not exist, for studies have largely consisted of separate and unrelated investigations – for example, of lighting, heating or acoustics. This has been convenient for the understanding of individual topics but not very helpful to the understanding of the whole, for the parameters interact. The Pilkington Research Unit has been established with the express long term aim of making scientific studies of the 'total environment'. Studies of the individual environmental factors and their interaction with one another, at both physical and subjective levels, are fundamental to the development of architecture.

The Unit's aim being long term, simpler objectives are necessary for the short-term stages of the study. This exploratory investigation has been centred on the design of offices because such a method of study has enabled many aspects of environment to be studied in relation to a building type which needs some fresh thought. The members of the Unit have been working to a common purpose but they have been individually responsible for those aspects of the study for which their qualifications best fit them. This report is an attempt to draw together the work of the Unit as a whole and also to present a unified picture of environment in the context of office design.

Several surveys of environment in offices have been conducted in recent years by administrators, public health inspectors, medical officers and others. Each one of the published reports has some interest, but by demonstrating that it is impossible for individuals or groups of laymen to possess all the necessary skills and experience to appraise the many aspects of an environment, they reinforce the need for a multi-disciplinary approach.

The building environment

The ramifications of building environment are endless. Conditions within a building are dependent on the surroundings, circumstances and climate outside. The form and relationship of building groups (eg, town centres) influences the design of individual buildings. Building owners' and architects' ideas about people's social and psychological needs will form a basis for fundamental policy decisions about a building's form, although there will be little or no evidence to substantiate them.

An example of this is the argument that, in terms of spatial layouts and environmental conditions, a building should be stimulating, for in that way it can optimally achieve its practical ends:

> 'Normal consciousness, perception and thought can be maintained only in a constantly changing environment; when there is no change a state of "sensory deprivation" occurs. Experiment has shown that a homogeneous and unvarying environment produces boredom, restlessness, lack of concentration and reduction in intelligence.
>
> This is the psychological basis for deliberately creating varying conditions in buildings. Office blocks in which each floor has the same layout, colour, materials and climate are just asking for trouble.... The sort of variation that we often demand instinctively on aesthetic grounds, has a sound physiological and psychological basis. A change in environment stimulates our built-in devices to perceive and respond rapidly to significant events and efficiency is thereby increased. It is worth paying for variety'.[1]

This argument, which is heard at many conferences and put forward by many architects when referring to open plan offices, seems to arise from a misunderstanding of what constitutes sensory deprivation. The existence of a book with that title[2] is well known to architects, but few have read it and understand that the effects described are the result of fairly gross sensory deprivation in the sense usually meant by psychologists. It is true, though, that some office environments are very dull and lack stimulus. Whether this has any implication for efficiency, what the optimal limits of environmental stimulation are, and how they are to be attained, are all questions yet to be answered. It is perhaps, therefore, premature to state that 'it is worth paying for variety'.

Yet if building environments have a major influence, good or bad, upon people's mental state, as well as upon their physical comfort and, possibly, health, then this is not something which should be left to chance, nor to inexpert investigation. There exists a clear need for research which will establish the facts.

One problem which has to be recognised in any such research is that people are not necessarily the best judges of what they need; they have a tendency to state a preference for the conditions with which they are most familiar. Furthermore, it is dangerous to generalise from one case to another without examining the differences between sub-samples of a population. This study has demonstrated that office staff's response to an environment are likely to differ according to the respondents' age, sex, status, and experience of working in other buildings. Some recent official studies of office conditions may be suspect because this matter, so far as can be seen, was not taken into account.

---

[1] **Noble, J: The how and why of behaviour: social psychology for the architect. Architects' Journal, 1963 (March 6)**

[2] **Soloman, P, (Ed): Sensory deprivation. Harvard University Press, Cambridge (Mass.), 1961**

Although their effect has to be seen in its totality, the major components of an environment have, unavoidably, to be considered separately.

Space

Today's typical office building has a linear plan-form with a building width of around 35 to 50 ft which consists, internally, of a central corridor with shallow offices on either side. The only substantial points of difference with many office buildings of the immediate pre-war period are external cladding and fluorescent lighting systems.

The most likely explanation for the continuation of this type of design is habit; a prolongation, possibly, of the traditional search for daylight. The feasibility of natural lighting in city centres is rarely questioned, even for first floor offices in densely built-up and overshadowed areas, and there is still a widespread belief that byelaws dictate a minimum window-to-floor-area ratio. The virtue of large windows has been part of the philosophy of the 'modern movement' in architecture for so long that it would be surprising if both architects and local authority planning officers had not been moulded to uncritical acceptance of the daylight 'slab'.

Yet another possible explanation can be attributed to the general preference for (or at least, expectation of) small-sized office spaces which is found in large organisations as well as small. However, an important consequence of departing from linear plan-forms and adopting deep buildings is the probable need for very large clerical areas (ie, open planning) so that people's view of daylight and the world outside the building shall not be obstructed by partition walls.

An examination of the attitudes towards small and large general office areas held by the three main hierarchical sub-groups of managers, supervisors and clerks showed that only managers were able to cite substantial advantages for the large spaces. Other users expressed a clear preference for smaller areas. Supervisors were the group most averse to large offices, their reasons mainly being in terms of 'keeping track of staff' and creating 'esprit de corps'. The clerks who least liked large offices were not the ones who worked in such spaces but the occupants of smaller, partitioned areas. This suggests that people may be more prepared to accept some (perhaps unusual) environmental features if they have already acquired some experience of them.

Sociometric studies have indicated some possible consequences for management of the choice between large and small work-spaces: small office areas containing single working units may help to generate within them small competitive teams whose immediate loyalties are to themselves, whereas large areas may produce a more generally collaborative whole. If this should be confirmed, the implication is that, where the performance of the work will be assisted by inter-group rivalries, small working areas should be provided. On the other hand, where work demands the co-operative efforts of many, the large areas may be found more effective. But whatever the relation between space-size and group cohesiveness or loyalties, buildings can only be designed to be most efficient and satisfactory in use if the operational consequences of the design decisions are understood.

Light

Historically, the purpose of windows was to provide light. It is now possible to do this more consistently and more reliably (perhaps, therefore, less interestingly) by electricity. Office workers are likely to say that they would rather work in daylight than electric light, and their belief in the importance of daylighting is shared by both physicians and architects. No objective support for this belief is known to exist, and an assessment of what constitutes a subjectively acceptable visual environment showed that in conditions where permanent artificial lighting and an unobstructed view of windows exists, people working substantially in artificial light tend to grossly over-estimate the proportion of daylight to artificial light on the working plane. The probabilities are that windows are really valued for their view to the exterior and that in the second half of the twentieth century this is their important function. The study suggests that daylighting provisions might more reasonably be made in terms of meeting subjective needs than of attaining arbitrary physical levels.

Modern technology is influencing the function of windows in other ways. An increase in the volume of traffic in city centres has created the problem of external traffic noise which is transmitted through the external fabric to the interior of the buildings, most of it going through the windows. Windows are usually kept shut in order to limit the annoyance but this affects their performance as ventilators. In many modern buildings the size of windows has created a problem of solar radiation gains and the consequent likelihood of the interiors becoming too hot. Windows occupy a central position in a study of building environment; the problem of their design is to reconcile the conflicting requirements which are made upon them.

Thermal conditions

Heating installations in modern office buildings are normally capable of providing comfortably warm conditions in the most severe winter. Nowadays office staff are likely to prefer a fairly high air temperature, in the region of 70 to 72°F. This is often provided but ventilation is rarely efficient and sensations of draughts, whether caused by movement of air or radiation from the body to cold surfaces like windows, are commonly experienced.

In some recent British owner-occupied office buildings a better control of the thermal environment has been obtained by the installation of complete airconditioning systems. These can remove unwanted heat gains from solar radiation and mechanical and electrical equipment, and control ventilation rates, air temperatures and relative humidities. Airconditioning plant will also eliminate the ingress of atmospheric pollution and, by permitting fixed windows, reduce the transmission of external noise.

Noise

Noise is perhaps the major environmental problem of offices in city centres. It is commonly believed that large general clerical areas present special difficulties in the control of internal noise but surveys have shown that this is not necessarily true. Although it is impossible to make unequivocal comparisons with smaller offices or with other buildings, the sound levels registered in one building in large open offices whose area is of the order of 35,000 sq.ft rarely exceeded 55 dBA. This was only slightly higher (and sometimes lower) than the sound levels recorded in smaller office areas in the same building and in offices of 20 to 40 people elsewhere. Much can be done to reduce the problem with suitable acoustic treatment of the ceiling and floor surfaces. Non-metallic waste bins and chairs with rubber-tipped feet will limit the amount of noise created within the office, and it has a better chance of being absorbed if the space is large, eg, upwards of 50 ft wide.

A substantial reduction of window areas, the use of double glazing, the elimination of opening lights and the use of heavy forms of construction in preference to light ones, such as curtain walling, will reduce the effects of street noise. But the only way in which the problem will be really solved will be by re-locating offices in quiet zones or, in the long term, by new town planning policies.

The environmental design process

The creation of the total environment has traditionally been the architect's job but it is now such a complex task that, in the most enlightened offices, multi-disciplinary design teams are found to be necessary.

Decisions which affect the office environment are seldom based upon research findings. This could scarcely be otherwise for there have been few user-requirement studies in buildings. Such topics as lighting and ventilation and heating have been studied in great detail by psychologists, physiologists and other specialists, but their influence has been less than might be expected. Environmental design has tended to mean the adaptation of a given constructional design by the piecemeal addition of lights, heaters, blinds, ventilators, and other fittings. There has been no serious movement to design commercial buildings around the functions they are meant to serve.

Environmental design is so complicated that it is not surprising that designers sometimes succeed in manufacturing their own problems. For obvious reasons a wholly intuitive approach cannot be very successful, yet this is the main basis of current practice, as, for the moment, it must be. Not only is there little positive design guidance available but the building educational system has been such that there are few designers who could or would use it if there were more. The provisions of recent office legislation are rudimentary, and offer no help; it is safe to say that the standards which have been established so far will be exceeded by a comfortable margin in all new office buildings. And the history of environmental legislation (consider, for example, the Factories Act) does not suggest that regulations, when they are made, will be unduly restrictive.

The design of office space is unlikely, in the immediate future, to change from being a matter of arbitrary decision and personal hunch. Because of the nature of their training most architects already qualified will continue to take a fragmented view of the design team's responsibilities in this particular sector. They will regard it as their task to deal with some parts of the problem and they will leave other parts to their specialist consultants. The consultants are likely to display a lack of interest in the total environment and they may interpret their responsibilities narrowly: concerning themselves solely with, say, the electric lighting design, or the thermal environment. Some matters will probably be taken for granted, including the place and function of windows, which, in all probability, will be designed for their effect upon the external elevations. The social consequences of design of office space will not be questioned, for it is probable that none will be expected. A change of attitude will only occur slowly, and must eventually be brought about by changes in architectural education. But it is not surprising that practising architects simplify their design process, even if it means curtailing consideration of important matters, for where environmental design procedures have been evolved they are often complicated, time-consuming and suspect.

There should be no doubt about the low efficiency of present design procedures and current attitudes to office environment: the results can be seen in that part of the approved 120 million or so square feet of post-war office space already constructed. It is fair to ask how many office buildings really are functionally efficient, and provide pleasant working conditions; how many really integrated examples of commercial architecture are to be seen, and how many buildings still look well after only a few years' use. The fault is not the architect's alone, for when he designs the buildings, the users are frequently unknown, and offices are sometimes badly mis-used.[3] Moreover, there is quite inadequate feedback of information to the architect about the performance of his buildings.

There is need for new thought about the requirements of office space, not least from building owners and users. Owners will need to take a more prominent part in preparing the brief than they do now, for, after all, they know best the use to which the building will be put. Unfortunately, a serious problem of understanding and communication is all too common. Langdon[4] has described this as happening in acute form in mechanised offices: the client is insufficiently analytical in preparing a detailed brief and the architect is too unfamiliar with the requirements to complete it himself.

The future office

A forecast of trends in office design is difficult, for there are few indicators; any buildings which do not follow the conventional pattern are 'one-offs', individually created for individual owners and owing little to previous or contemporary British examples. Occasionally, for very important buildings, client-architect teams have studied current American practice. No other country seems to have exerted any major influence although, recently, the concept of 'bürolandschaft', which was developed in Germany,[5] has provoked a good deal of discussion.

Figure 1
Office buildings in New York.

If the supposition is correct that a large proportion of the total demand for office space is, and will remain, for small units of area (whether in size of tenancy or number of private offices), then it is probable that in, say, twenty-five years' time, the greater number of office buildings built for letting will still be very much the same as they have been during the past quarter-century. There is little in the history of speculative office building to suggest radical experimentation.

More substantial changes in office design can be expected from owner-occupiers than from property speculators. Although there are many examples of ultra-conservative buildings in the ownership of their users, it is this group which has been responsible for the few outstanding departures from the conventional pattern. The

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[3] See, for example: **Casson, Hugh:** The executive slum. *Sunday Times* colour magazine, 1964 (January 5)

[4] **Langdon, F. J:** The design of mechanised offices. Architects Journal, 1963 (May 1 and 22)

[5] **Duffy, Francis:** Bürolandschaft. Architectural Review, 1964 (February)

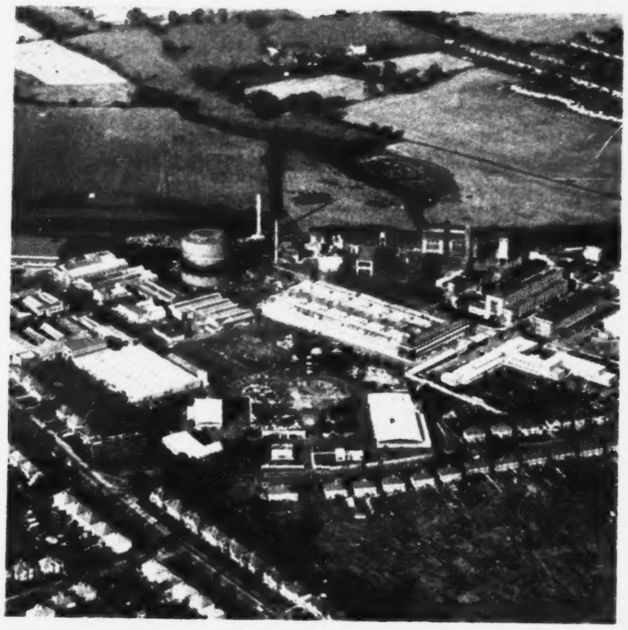

Figure 2
The headquarters of the West Midlands Gas Board was transferred from the centre of Birmingham to the suburbs: the very large, single-storey building is at 4 o'clock from the gasometer.

trends suggested by these forward-looking buildings can be discussed under the headings of location, character, environment, amenities and flexibility.

Location

In the absence of specialised out-of-town sites for offices on the pattern of industrial estates, office buildings for letting are likely to remain in central or metropolitan positions. Owner-occupiers are not so tied and it seems probable that an increasing number, especially those which have no need for frequent and personal contact with the public or other businesses, will take advantage of the greater availability and cheapness of land, the easier access and the possibilities of a better environment which are offered by the provinces and suburbs. One result of decentralisation and cheaper sites is likely to be lower buildings and, in consequence, increased efficiency in the use of space and lower building costs.

Character

Two divergent trends in the character of office space can be seen. They are, on the one hand, the increasing mechanisation of clerical procedures which produce the atmosphere of clean factory areas and, on the other, the refinement and elegance of an increasing number of private offices. The trends are so different, yet so marked, that it seems possible that this is the watershed in the current development of office design. Clerical work in the past has been performed by numerous relatively well-educated but low-ranking clerks; now mechanisation makes it possible to replace clerks with machine-minders. Since the output of information from machines is so many times greater than from clerks, there has arisen a new and large strata of 'junior management' which plans and sifts the machines' work. If the top executive strata is disregarded, an office hierarchy now consists of two layers. One is an enlarged officer-corps of junior executives which satisfies the need of top-management for more control information and, in so doing, creates a need for machine work. The other is an army of machine operatives. As machines increase in efficiency and output this second group must steadily decrease in numbers. At the moment it is still increasing, due to both bureaucracy and the increasing requirements for more data.

Environment

Most contemporary office buildings provide only undistinguished environments. In comparison with the environments within pre-war offices they are likely to be better in some respects (visually, perhaps), and in others (eg, acoustically) to be worse. But a number of owners who have recently constructed buildings for their own occupation have used high quality finishes and advanced modern services to create quite impressive environments. The main features are high standards of comfort: high levels of illumination from electric lighting, air temperatures of 70 to 72°F and increasing use of airconditioning for thermal comfort, reduced noise and increased cleanliness. Environmental provision either stands still or improves (it goes back only during historical 'dark ages') so it is reasonable to assume that what is now exceptional will eventually become general.

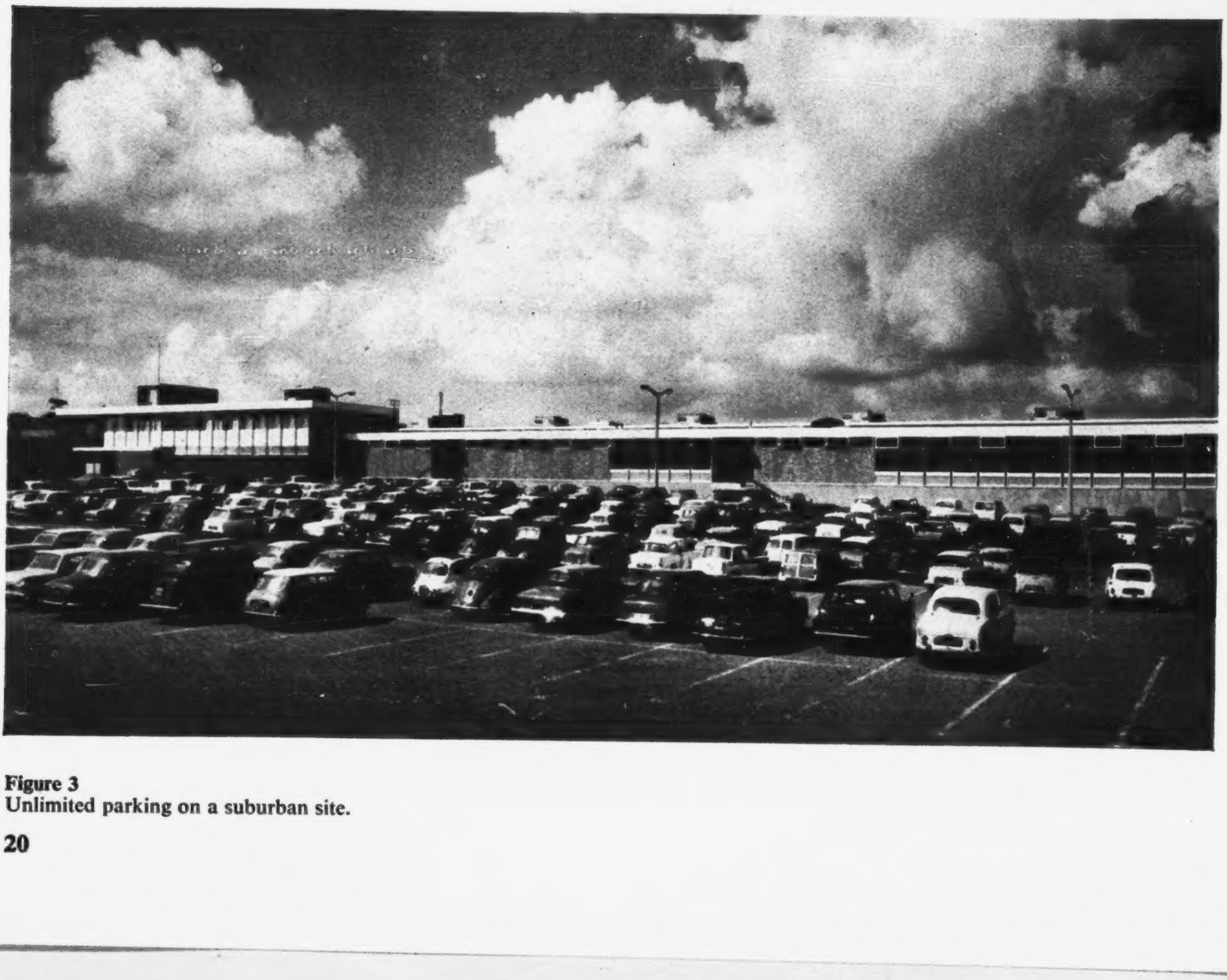

Figure 3
Unlimited parking on a suburban site.

Figure 4
Amenity: lavatories.

Figure 5
Amenity: dining room.

Amenities

Side by side with improvements in the environment of the workplace will come improvements and higher standards in amenities, especially in such spaces as lavatories, canteens and recreation spaces. The importance of lavatories, in particular, ranks so highly with women office staff that it will seem especially worthwhile for owners building offices on restricted budgets to give this space more generous attention than it commonly receives.

Flexibility (or adaptability)

The likelihood of change in office work and in the use of office space has become so great that it is now usual for a measure of 'flexibility' to be built into a new office building. The use of modules is convenient for construction at least as much as for adaptability in use. Increasing use of industrial methods of building will inevitably result in even greater use of dimensional standardisation. Demountable partitions are used extensively to meet present needs for both private offices and flexibility. Their functional requirements of lightness and sound insulation are in obvious conflict; in practice it is both difficult and expensive to achieve any useful sound insulation from demountable partitions in combination with suspended ceilings. It is possible that such problems in the use of partitions will be resolved by their omission.

A trend to open planning in owner-occupied offices

In most commercial establishments O and M departments seem to occupy a relatively lowly position, being more concerned with method than organisation, so an impression acquired during this study that the building requirements of office functions have not been appraised very critically is probably true. This helps to explain the lack of any clear and positive directions in the planning of office spaces by commercial organisations. Taken together, the likelihood of increasing needs for flexibility and for inter-office communication, the use of mechanical or electronic procedures, and the findings that the lighting requirements of clerks can, in suitable circumstances, be adequately met by well designed artificial lighting, suggest the suitability for more widespread use of deep, artificially lit office buildings. These will need to contain open-planned office space, with a minimum of partitions and a maximum size of window, so that staff working in the interior of the space have an adequate view to the outside world.

The choice between slab or block design is, however, one which in general can only be made by owner-occupiers: deep buildings are unlikely to be suitable for letting, unless it can be expected that the unit of letting will be a whole floor. Office layouts approximating to this form have often been used for junior staff employed on routine work and they are also quite common for highly-paid professional and technical staff in drawing offices. But they are rarely used for junior and middle grades of clerical office management in this country, although the practice is common in the United States. Indeed, the most senior executives of some firms in that country work in shared offices for the express purpose of achieving better communications and rapid decision-making. From this point of view, private rooms for any staff are less efficient than open offices just because they restrict opportunities for direct and informal communication. They are also more expensive in both spatial and economic terms.

It is possible, then, that an important trend in the design of owner-occupied office buildings will be towards deep, open-planned space, for this is certainly the most flexible arrangement. Full airconditioning is likely to become more necessary and therefore more common.

The lessons of the project for further environmental research

This office building research project has been a first experiment in the working of a particular type of multi-disciplinary research team and, for at least half the members of the team, an introduction to architecture and building problems. This report must necessarily be regarded as an interim statement, constituting a starting point for further studies. Besides reviewing much work already published, the team has explored several new fields. Inevitably, a great deal has been left outstanding.[6]

The most important points of office design needing further attention are first: an examination of sizes of office occupancy, and second: studies of the nature of office work as it affects the need for office space.

The study has shown that the working environments which architects create will influence human behaviour in many ways, and the value of psychological investigations of building design problems has been demonstrated. There are a number of questions of particular psychological importance which need further work to develop the line of investigation which has been opened

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[6] See appendix 1.1

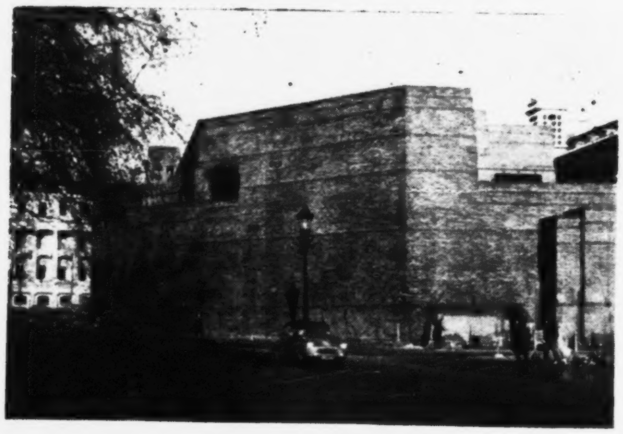


Figure 6
Windowless environment.

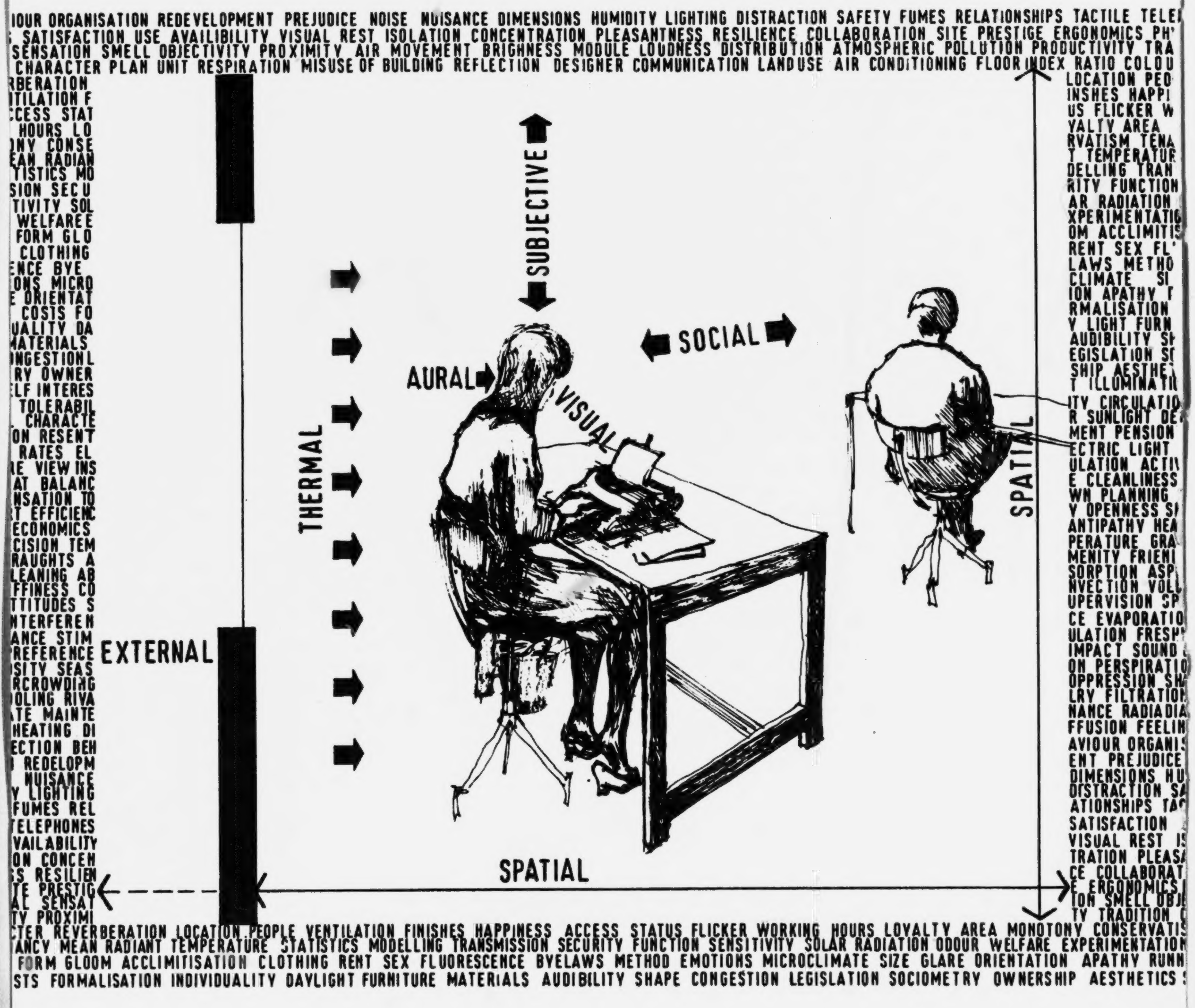
up, notably, perhaps, the degree to which one environmental factor affects the subjective experience of another. There is much anecdotal, and little experimental, evidence in this field, yet it is likely to be at the very root of an understanding of the total environment.

The use of a 'building type study' as the basis for research into the total environment has, on the whole, been successful, for it permits examination of all or most of the environmental factors. But it has the disadvantage that it becomes difficult to separate what unavoidably become the two objects of the work, ie, the environmental aims of the long-term research programme and the building-type problems thrown up by the immediate investigations. The Unit already has two building-type projects running simultaneously; it now seems advisable to change one of these to an expressly environmental project. A single-parameter study would be a retrogressive step; what is wanted, perhaps, is a multi-building-type study. One possibility is a consideration of the 'windowless' environments which are increasingly being provided in such a variety of buildings as department stores, underground railways, photographic laboratories, race-track-plan hospitals, factories and, perhaps, even space-craft and submarines.

Finally, a necessary task which remains for the future is the establishment of a means to evaluate and compare total environments. It is already abundantly clear that it will be difficult to devise a method which can secure general acceptance: the number of thermal comfort scales in use (for example) indicates the problems of weighting the components of even a simple index.

Stage Three
Part One

The components of environment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Chapter 2

Introduction

This publication reports upon a study of environment which was based on the design of office buildings and office space. The study forms part of a continuing programme of environmental research which is sponsored by Pilkington Brothers Limited of St Helens, and succeeds the previous investigation of factory building design.[1]

At the time of writing, 'environment' is a word in popular use, especially in connection with architecture, but it tends to have different meanings and implications for different people. In this report it is taken to be the sum of the physical and emotional sensations experienced by people within buildings and arising out of their use of those buildings. These sensations include bodily comfort, aesthetic sensibilities and social relationships; they may originate in the external climate, the location and the social milieu, but they are influenced and modified by the building's design.

The *long-term* aim of the research is the academic development of an understanding of this 'total environment'. A building type is a convenient base for such studies because it provides real situations in which many of the component environmental factors are acting together.

The choice of offices as such a base was made for a number of reasons. This building type seemed to be a natural progression from factories because it was another workplace, with related functions and similar purposes. The annual capital investment was unknown (there are no central agencies maintaining records) but was believed to be high. No current research into this building type was known apart from a user-satisfaction survey by the Central Office of Information[2] and a study of the design of space for automatic data processing by the Building Research Station.[3] It was considered more worth-while to investigate building types where the gap between knowledge available and knowledge applied to design was not very wide; contemporary practice in office design did not lag significantly behind existing knowledge, indicating a need for some new thought. Many buildings were available for study, there seemed no necessity for the Unit to obtain staff with specialised knowledge of the building type and opportunities for studying environment were plentiful.

The form of the office project has been as follows:[4]

(i) A series of background studies to compile a bibliography and define the characteristics, population and distribution of post-war office buildings.[5]

(ii) Preliminary visits to a representative sample of buildings in Liverpool, Manchester and elsewhere.

(iii) A series of detailed investigations of environmental conditions and other matters.[6] Physical conditions were examined in a sample of nine buildings. Psychological studies of clerical staffs' attitudes towards their physical and social environment were made in the new headquarters office building of the Co-operative Insurance Society (the CIS) in Manchester, which houses more than 2,500 staff.

(iv) Individual reports by the four research staff:

  (a) a general survey by the architect of the literature relating to office design and environment

  (b) an account by the geographer of the general characteristics, population and location of post-war office buildings in England and Wales

  (c) a report by the physicist upon the results of surveys in offices of thermal conditions in winter and summer, noise, and lighting

  (d) a report by the psychologist upon the response of the CIS staff to their working environment and its implications for office design.[7]

These four separate reports have been combined together to form this present 'multi-disciplinary' report. Although an environment is experienced as a whole, with all the different stimuli acting simultaneously, this report has necessarily to deal with the more obviously important components in isolation. The next chapter provides an overview of the main characteristics of the office building type and a description of the buildings which formed the preliminary survey sample. In the succeeding six chapters, present knowledge of the effects of location and the spatial, visual, thermal, aural and social environments is summarised. The Unit's studies are drawn upon to fill some of the gaps. Chapter ten consists of a case-study of the total environment in the CIS building.

This report represents a stage in the development of the Pilkington Research Unit's studies of the total environment within buildings and is therefore primarily addressed to other research groups engaged in systematic studies of architecture. But it also indicates an approach to design from the basis of the environment which people working inside buildings experience. The response to a short course on office design and environment which the Unit based on this material[8] suggested

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1. **Manning, Peter:** The design of roofs for single-storey general-purpose factories. Department of Building Science, University of Liverpool, 1962
2. **Central Office of Information:** Report not yet published, but drawn upon in: **Langdon, F. J.** and **Keighley, E. C:** User research in office design. Architects' Journal, 1964 (February 5)
3. **Langdon, F. J:** The design of mechanised offices. Architects' Journal, 1963 (May 1 and 22)
4. For a detailed description of the organisation of the research see: **Manning, Peter:** The organisation of a programme of research. Architects' Journal, 1964 (December 30)
5. **Taylor, Sheila:** Post war office building: a survey. Architects Journal, 1962 (December 19)
6. See appendix 2.1
7. **Wells, B. W. P:** Office design and the office worker. Ph.D thesis, University of Liverpool, 1964
8. **White, W:** Liverpool University: office design and environment. Architects Journal, 1964 (October 21)

that to many architects and building owners this is a new way of thinking about buildings. It is hoped, therefore, that the report will also prove of interest to a wider audience than the present limited circle of architectural research workers.

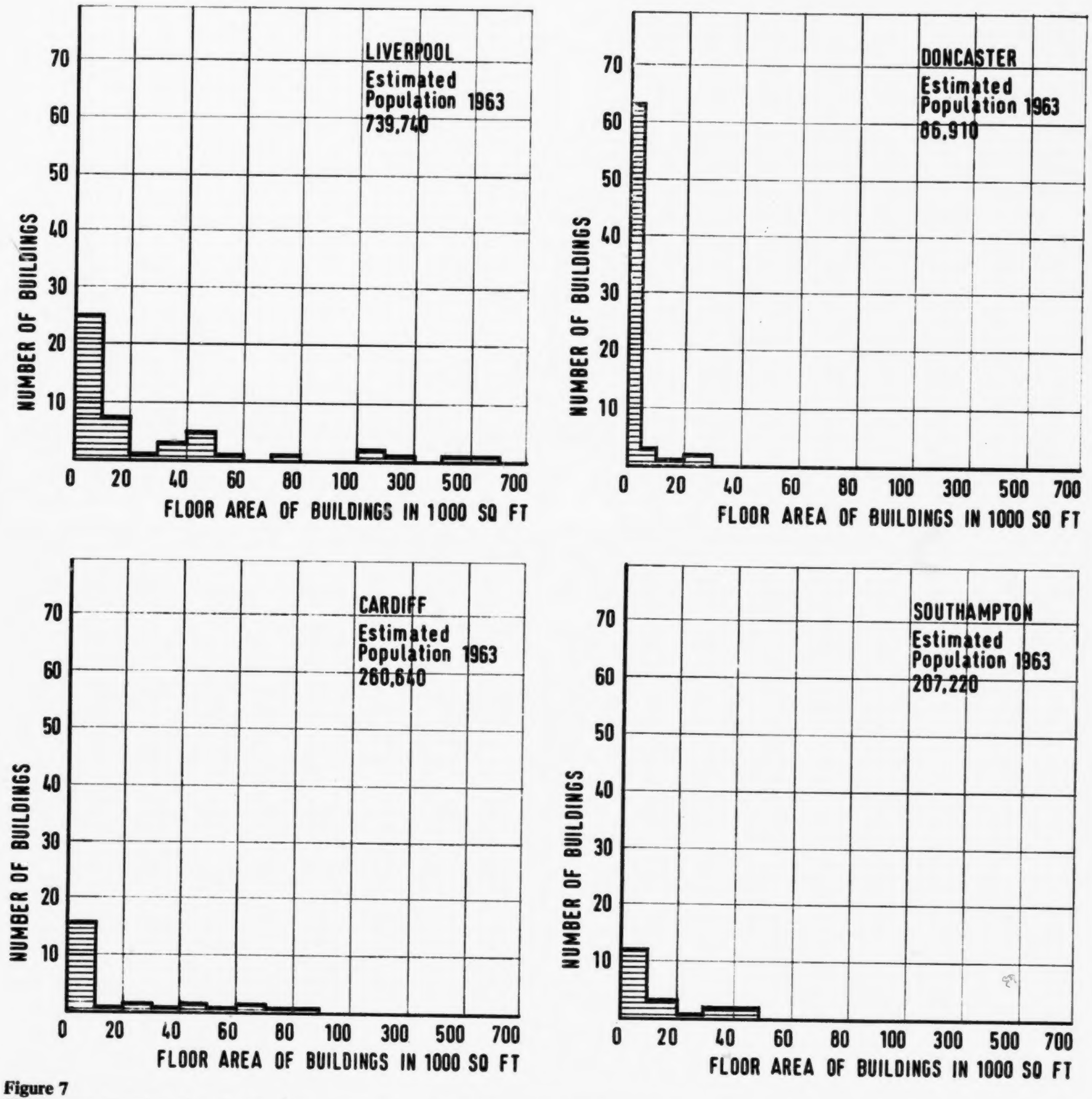

Figure 7
Histograms showing size distribution of office buildings constructed post-war in four towns.

Chapter 3

Background to the environmental studies: The building type

The term 'office' is used very loosely. Perhaps the main distinction to be made is between the office *building* and the office *space*[1] within a building. Although an office building may be designed entirely for office use, it is quite likely to consist of one or more floors of office space above such other accommodation as shops, banks, public houses, etc., or be attached to a factory or warehouse. Recent office legislation[2] has defined office premises as '... a building or part of a building ... the sole or principal use of which is as an office or for office purposes.' 'Office purposes' include administration, clerical work, handling money and telephone and telegraph operating; 'clerical work' includes writing, book-keeping, sorting papers, filing, typing, duplicating, machine calculating, drawing and the editorial preparation of matter for publication. This definition describes the operations which go on within the office but it does not explain its function. An explanation of this type is given in a standard handbook on office organisation and methods: '... in the O and M context "the office" is primarily the administrative headquarters of the business which provides management with a service of communications .... (and) ... a record of past transactions and operations.'[3]

The building

Types of space within office buildings

Not all the space within an office building is office space for there are in addition the 'service' spaces of lavatories, boiler rooms, canteens, lift lobbies, staircases, etc. The proportion of office space to the floor area of the whole office building may be of the order of less than 50 up to a maximum of about 80 percent.

Office space may comprise reception and waiting areas, conference rooms, general offices, private offices, typing pools, machine rooms (for noisy accounting machinery, etc.) and filing and storage areas. Most businesses have a need for some of these spaces. Their relative importance depends on the nature and practice of each individual business.

Size of buildings

Information about the floor areas of offices constructed in the post-war period has been sought from the local planning authorities.[4] The typical range of areas of office space in individual buildings was defined as:

small office buildings: less than 20,000 sq. ft of office space

medium office buildings: 20,000 to 100,000 sq. ft of office space

large office buildings: over 100,000 sq.ft of office space.

In this instance, the term 'office space' refers to the total amount of office floor space in one building, whether this occupies the whole of it or only a part.

Figure 8
Most new office buildings are quite small.

Although it has not been possible to collect statistics of all post-war office construction, it appears that a large proportion of the total consists of very small buildings, ie, areas less than 10,000 sq.ft.[5] In Hertfordshire, for example, 86 percent of projects, and in Surrey 80 percent of projects have been below this figure. The number of projects whose size is greater than 100,000 sq. ft is small and, outside the larger towns, individual office buildings with areas exceeding 50,000 sq. ft are rare. Most new office buildings, especially in the smaller towns, have between one and five storeys, the greater number being of only one or two storeys, especially when they are attached to industrial premises. Much higher buildings are to be found in the larger towns, buildings over 12 storeys high being not uncommon. The 34-storey Vickers building in London is at present the British office building with the greatest number of floors, though it is not the tallest.

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[1] This research project has been concerned specifically with 'office space', whether it comprises the whole or part of an office building

[2] Offices, Shops and Railway Premises Act 1963. HMSO

[3] **Milward, G. E.** (Ed): Organisation and methods. Macmillan. Revised edition, 1962

[4] See chapter 4, appendix 4.1 and **Taylor, Sheila:** Post-war office building: a survey. Architects' Journal, 1962 (December 19)

[5] **Taylor, Sheila:** op cit (4)

Ownership
The ownership of post-war office buildings seems to fall into three groups: local or national government, speculative developers, and owner-occupier commercial firms. Only a small proportion is government owned, the remainder being approximately equally divided between speculative and other private developers. Speculative buildings have usually been commissioned by insurance companies, building societies and other property and holding companies; they often accommodate a small branch office of the owners, the bulk of the space being let. Other privately owned office buildings have been built by banks, newspapers, manufacturers, retailers and others. Such owners often occupy a considerable proportion of the office space, and let on short lease that area which is superfluous to their present needs. Government departments are extensive users of office space, mostly in rented property. Comparatively few new Crown buildings have been built.

Mixed uses of office buildings
Buildings containing office space very often have other uses too and although the building's primary use may be for offices, in some cases this may represent only a small proportion of the total floor area. The most common arrangement consists of shops on the ground and first floors and offices above. Car parking space is sometimes included within the building and might occupy basement or ground floor space.

Types of user and tenancy
Information is needed about the type of business in which office users are engaged, for it is probable that this would have important implications for the design of office space. Possibly the most useful data would be a frequency distribution by number of employees and SIC Orders.[6] But at the moment there are no figures available which show such a breakdown and, if this office project should be extended, it is probable that one of the first tasks would be to establish one.

Size of occupancy
Another important matter which has not yet been investigated is the range of size of office occupancies, including both owner-occupiers and tenants. This information is needed for the planning of cities, as well as office buildings, for the size of an occupancy can determine suitable dimensions for the building's width and depth, and indicate points of access. Street patterns, especially in comprehensive redevelopment schemes in central areas, are subsequently influenced by the size and shape of building blocks.

Designers
According to a survey of new commissions for private architects,[7] in the years 1955 to 1957 the design of commercial buildings (in this case, offices and banks) represented about 30 percent of private architects' work. It was also estimated that 90 percent of all commercial buildings were designed by private architects. It is not now possible to say that these percentages are still applicable for, since that survey, the RIBA revised the basis for its collection and analysis of statistics and commercial buildings are no longer quoted separately.

Legislation affecting the siting and design of office buildings

Office buildings are subject to three main items of legislation: the Town Planning Act,[8] Building Byelaws,[9] and the Offices, Shops and Railway Premises Act.[10]

Town Planning Acts are the instruments used to control development and amenities. There are no provisions specifically relating to the environment within offices but the general application of the Acts gives power to local authorities to determine siting, building use, daylighting zones, building height, car parking, the appearance of buildings and many other matters.

Building Byelaws. Although there are plans for the creation of national building byelaws which will apply across the whole country, at present the Model Byelaws published by the Ministry of Housing and Local Government are used by local authorities as the basis of the byelaws adopted for and applicable to their particular areas. The Model Byelaws have no specific requirements of environment within office buildings (which are classed as 'domestic buildings') and most of the clauses are, intentionally, couched in general terms eg, 'Every storey of a domestic building shall be provided with effectual means of ventilation'.

The Offices, Shops and Railway Premises Act. Over many years there have been a number of attempts to introduce legislation which would control the working conditions of non-industrial employees (ie, principally clerical workers) but, until recently, they have been unsuccessful. In 1946 a committee of enquiry was appointed by the government to enquire into (amongst other matters) '. . . the statutory provisions relating to the health, welfare and safety of employed persons at places of employment other than those regulated under the Factories or Mines and Quarries Acts . . .' The committee's report (the 'Gowers Report')[11] summarised existing legislation and made recommendations which, in respect of shops and offices, were substantially that the provisions of the Factories Act should apply to these two building types. The report became a standard for those endeavouring to raise the working conditions of office staff, but no action was taken by any government until, in 1960, a private member's bill (the 'Marsh Act') reached the statute book.[12] This Act gave the Secretary of State power to make '. . . regulations specifying the standards as to structure, arrangement and operation to be applied in offices for the protection of the health, safety and welfare of persons employed therein . . .' but no regulations were ever made, for the government introduced its own legislation and this, in the form of the Offices, Shops and Railway Premises Act 1963 repealed the Offices Act and was operative from 1st August 1964.[13]

The purpose of the Act is '. . . to make fresh provision for securing the health, safety and welfare of persons employed to work in office . . . premises . . .' which are defined as '. . . a building or . . . part the sole or principal use of which is as an office or for office purposes . . .'.[14] The Act is *not* applicable to certain offices such as those in which the only staff are relatives of the employer or where a maximum of only 21 man-hours per week is worked. Those parts of the Act appropriate to a consideration of environment are discussed in later chapters.

The people who work in the building

Numbers of office staff
It is generally believed that there are now approximately

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[6] **Central Statistical Office:** Standard Industrial Classification. HMSO. Second edition, 1958

[7] **Anon:** A survey of private architectural practice. J Royal Inst Brit Archt. 1959 (April)

[8] Town and Country Planning Act 1962. HMSO

[9] **Ministry of Housing and Local Government:** Model Byelaws, Series IV: Buildings. HMSO, 1953

[10] Offices, Shops and Railway Premises Act 1963. HMSO

[11] **Home Office and Scottish Home Department:** Health, welfare and safety in non-industrial employment. Hours of employment of juveniles. Report by a Committee of Enquiry. Cmd 7664. HMSO, 1949

[12] Offices Act 1960. HMSO

[13] Builder, 1964 (January 3) p. 33, reporting the Minister of Labour

[14] See the beginning of this chapter for definition of 'office purposes'

three million clerical workers in Britain[15] and, if the proportions of men to women have not changed substantially since the 1951 census, about 60 percent are women.

Together, office and shop staff account for about 80 percent of all employed persons other than those engaged in industrial or domestic work.[16]

Types of office staff

The main types of staff who may be housed in offices have been categorised[17] as

(i) typists
(ii) secretaries
(iii) machine operators
(iv) clerks
(v) specialists – eg, draughtsmen and telephonists
(vi) 'transitory' staff – eg, salesmen, inspectors
(vii) managers and supervisors
(viii) 'advisory' staff – eg, in laboratories, studios, strongrooms
(ix) executives
(x) service staff – eg, canteen staff, drivers, building maintenance workers

In this study emphasis has been placed upon the general office areas which are staffed mainly by clerks and, to a lesser extent, typists, machine operators, and supervisors.

Occupational health of office workers

In a paper demonstrating the need for legislation to regulate the working conditions of non-industrial workers, Wattleworth[18] collected together a number of statistics bearing upon the occupational health of clerical workers. He said[19] that the incidence of respiratory tuberculosis among clerks was 38 percent higher than the average for the country and anaemia twice as heavy as among agricultural workers. The average mortality rate from rheumatic heart diseases, coronary heart disease, pneumonia, ulcers, diseases of the liver and nephritis was higher than the average for the country;[20] the number of spells of incapacity due to sickness in agriculture is 9 per 10,000, for all workers 33 per 10,000, but for clerical workers 47 per 10,000.[21]

Wattleworth appears to assume that there may be a direct relationship between the working conditions of office staff and their liabilities to particular kinds of ill health, but this has hardly been established. Taylor and Wood remarked[22] upon the lack of knowledge of the risk of infection to which office workers are exposed but drew attention to some evidence[23] that risks are less in small than in large units. McGirr remarked[24] that clerical workers include a higher proportion of disabled persons than industrial workers.

A belief is widely held by office managements and others that good working conditions encourage efficiency (or 'productivity') and bad conditions contribute to high staff turnover rates. So far, no such relationships have been adequately proved.

Published surveys of offices and their environment

Since the end of the war a number of reports have been published of extensive surveys of office design and working conditions. These include:

(i) physical working conditions in the civil service[25]
(ii) the state of office lighting[26]
(iii) environmental conditions in offices and work places in part of the central area of Liverpool[27, 28, 29]
(iv) standards of office accommodation in Barrow-in-Furness[30]
(v) occupational health conditions in the City of London[31]
(vi) a user study of eight offices which employ automatic data processing equipment[32]

The Central Office of Information is known to have made a nation-wide survey of working conditions in post war offices. The results have not been published, although the material has been drawn upon by Langdon and Keighley for an article describing user research in office design.[33]

The findings of these surveys will be reviewed in subsequent chapters which deal with specific environmental topics. Their aims and methods were as follows.

The survey of civil service buildings had as its main purpose the consideration of how efficiency might be increased by up-grading working conditions to the best standards prevailing in commerce and industry. It was made between April 1943 and September 1944 by a working group drawn from various government departments. The task included reviewing environmental and other standards, assessing the extent to which these were met (including consideration of possible variations between departments) and comparing civil service conditions with those of 'outside industry'. The method adopted was to '. . . get some knowledge of theory and of expert opinion . . .'[34] on the elements of the problem, and to visit contemporary industrial and commercial office buildings and all types of government offices.

The office lighting survey was undertaken in February 1948 by the Central Office of Information to '. . . obtain information about the general state of natural and artificial lighting in offices in Great Britain with regard both to the facilities available and to the workers' opinions . . .'.[35] It took the form of a statistical analysis of the replies to a questionnaire completed in respect of 1,408 office workers and a correlation of those replies with the physical conditions of the 358 offices in which they were obtained.

The Liverpool survey was commenced in 1955. Its purpose has not been explicitly stated, but from the manner in which the findings have been published[36] it can be assumed that it was undertaken partly in the course of

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15. See, for example, a report of a talk by **L. A. Hill** of Shell International Petroleum Co. in *The Guardian*, 1961 (November 24). The results of the 1961 Census in terms of occupation were not available when this report was written
16. **Home Office and Scottish Home Department**: op cit (11)
17. **Manasseh, Leonard** and **Cunliffe, Roger**: Office buildings. Batsford, 1962
18. **Wattleworth, W. H**: The forgotten army. Royal Society of Health Journal, 1959 (March-April)
19. Referring to a statement in the House of Commons and the Registrar General's report for England and Wales for 1951
20. Referring to the Registrar General's report for England and Wales for 1951
21. Referring to a statement in the House of Commons by Mr Yates and to Hansard (1958, 24 January). The figures originated in the Registrar General's report for 1951
22. **Taylor, (Lord)** and **Wood, C. H**: Occupational health services in smaller work places in Britain. Chapter 19 in: Modern trends in occupational health. Ed: **Schilling, R. S. F.**, Butterworth, 1960
23. **Stewart, A.** and **Hughes, J. P. W**: Tuberculosis in industry: an epidemiological study. Brit Med J, 1959 1 926
24. **McGirr, P. O. M**: The health aspects. Paper to a conference on 'Efficiency in the office' organised by the Industrial Welfare Society in March 1964. (Unpublished)
25. **Study Group appointed by H.M. Treasury**: Working conditions in the Civil Service. HMSO, 1947
26. **Gray, P. G.** and **Corlett, T**: A survey of lighting in offices. Appendix to Post-war building studies no. 30. HMSO, 1952
27. **Wattleworth, W. H**: Unfinished business in environmental health. Royal Society of Health Journal, 1958 (May-June)
28. **Wattleworth, W. H**: 1959, op cit (18)
29. **Wattleworth, W. H**: Health and welfare of the office worker and others engaged in non-industrial employment. Paper to conference of public health inspectors at Scarborough, 1960. (Duplicated typescript)
30. **Nelson, I. D. M.** and **Morse, R. J**: A pilot study of office accommodation. The Medical Officer, 1960 (September 9)
31. **Robinson, Alan**: Working in the city: the interim report of a survey. City of London Health Department, 1962 (December)
32. **Langdon, F. J**: The design of mechanised offices. Architects' Journal, 1963 (May 1 and 22)
33. **Langdon, F. J.** and **Keighley, E. C**: User research in office design. Architects' Journal, 1964 (February 5)
34. **Study Group appointed by H.M. Treasury**: op cit (25)
35. **Gray, P. G.** and **Corlett, T**: op cit (26)
36. **Wattleworth, W. H**: (1958, 1959 and 1960) op cit (27, 18, 29)

Figure 9
Within Liverpool's business area.

the normal work of a public health department, partly to support a case for establishing protective legislation for non-industrial workers. The survey combined information from routine inspections and the results of a pilot survey specially undertaken by the city corporation, in the course of which the accommodation of 1,900 firms in commercial premises was inspected.

The Barrow-in-Furness survey was carried out jointly by the town's medical officer and deputy chief public health inspector, as a pilot survey of the standards of office accommodation in a 'medium-size'[37] town. Fifty offices were visited, these being chosen at random from those which met the definition of the Gowers' Report,[38] '. . . premises in which persons are employed in clerical work, including book-keeping, filing, typing, multigraphing, machine calculating, and drawing' but excluding offices forming part of factories, workshops or shops. The enquiry was mainly observational, ie, room dimensions, lighting and temperature were measured but a direct question was asked about noise. The survey took place between October 1959 and June 1960.

The City of London survey was of the 'health and environment of City non-industrial workers, to compare their working conditions with those likely to be proposed in future legislation and to ascertain the practicability and support by employers for an occupational health service for the City of London'.[39] The whole of the field work, which involved visits to 267 businesses, including 186 offices, and measurements of environmental conditions in 1,823 rooms was carried out by one assistant medical officer of health especially appointed for the study. The field work took place during the period March to September 1962.

The user-study of mechanised offices was made by the Building Research Station because it was found that many firms changing over to mechanised office procedures were experiencing difficulty in obtaining suitable accommodation or had noise, ventilation, or other problems. The work started about 1959 and finished in 1962, and consisted of functional and environmental studies of eight buildings in which staff reactions to workplaces were correlated with physical measurements of the actual conditions.

The Pilkington Research Unit's preliminary survey of offices

The Unit's preliminary visits were to 21 buildings in the north-west of England which were representative of 'large', 'medium' and 'small' office buildings.[40] A total of 37 businesses occupying space within these buildings was visited. The sample included different departments of central and local government, representative professions, public corporations, insurance, shipping, industry, chain stores and the building industry (table 1). The areas of office space in individual occupation ranged upwards from 200 to several hundred thousand square feet.

The impressions gained from these visits have formed a general background picture for the more detailed investigations, and an attempt at generalising this experience is made to help in setting the scene for subsequent chapters.

Table 1
Analysis by Standard Industrial Classification of business interest of 37 firms visited during preliminary stage of project

SIC Order		No. of firms
I	Agriculture, Forestry, Fishing	1
IV	Chemicals and Allied Industries	1
VI	Engineering and Electrical Goods	1
X	Textiles	1
XV	Paper, Printing and Publishing	1
XVII	Construction	1
XIX	Transport and Communication	5
XX	Distributive Trades	6
XXI	Insurance, Banking and Finance	7
XXII	Professional and Scientific Services	2
XXIII	Miscellaneous Services	4
XXIV	Public Administration and Defence	7
	Total no. of businesses	37

Note. Unless a firm was known to be a wholesaler or factor without manufacturing capacity, the classification was by SIC Order of the original producer

Description of the buildings which formed the survey sample

All but one of the buildings were situated in city centres. Their owners were mostly commercial organisations (such as insurance companies) which had built the offices as investments and let the office space, either directly or through agents, to a variety of tenants. A small number were owned and occupied by central and local government; another group was owned by commercial firms which occupied the floor area they needed and let the remainder on short lease. One building consisted of a semi-industrial depot where the office accommodation was only a small proportion of the whole. Two others were described by their users as having originally been intended for development as department stores. The majority were designed and built as offices, but the ground floors were often used for other purposes. The total amount of office space in a building varied upwards from less than 500 sq.ft; the total area of individual buildings in the sample varied downwards from about 400,000 sq.ft. The number of storeys above the ground floor was often 4 or 5, a smaller number 9 or 10 storeys, and one or two higher still.

With the exception of one building, which had been built before the war, all the offices were new since 1954, some having been built very recently. The period of construction was typically two years.

Internal finishes tended to be simple and were commonly plaster for the ceilings (direct to the concrete floor structure) and thermo-plastic tiles for the floors. Other floor finishes used were linoleum, wood block and rubber

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[37] Population 65,000
[38] **Home Office and Scottish Home Department:** op cit (11)
[39] **Robinson, Alan:** op cit (31)
[40] See **Taylor, Sheila:** op cit (4) and page 27

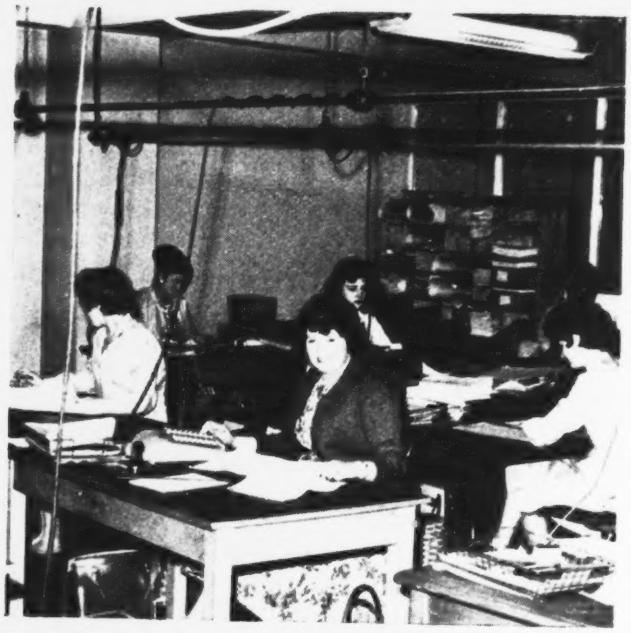

Figure 10
Upper floor of a department store adapted for clerical use.

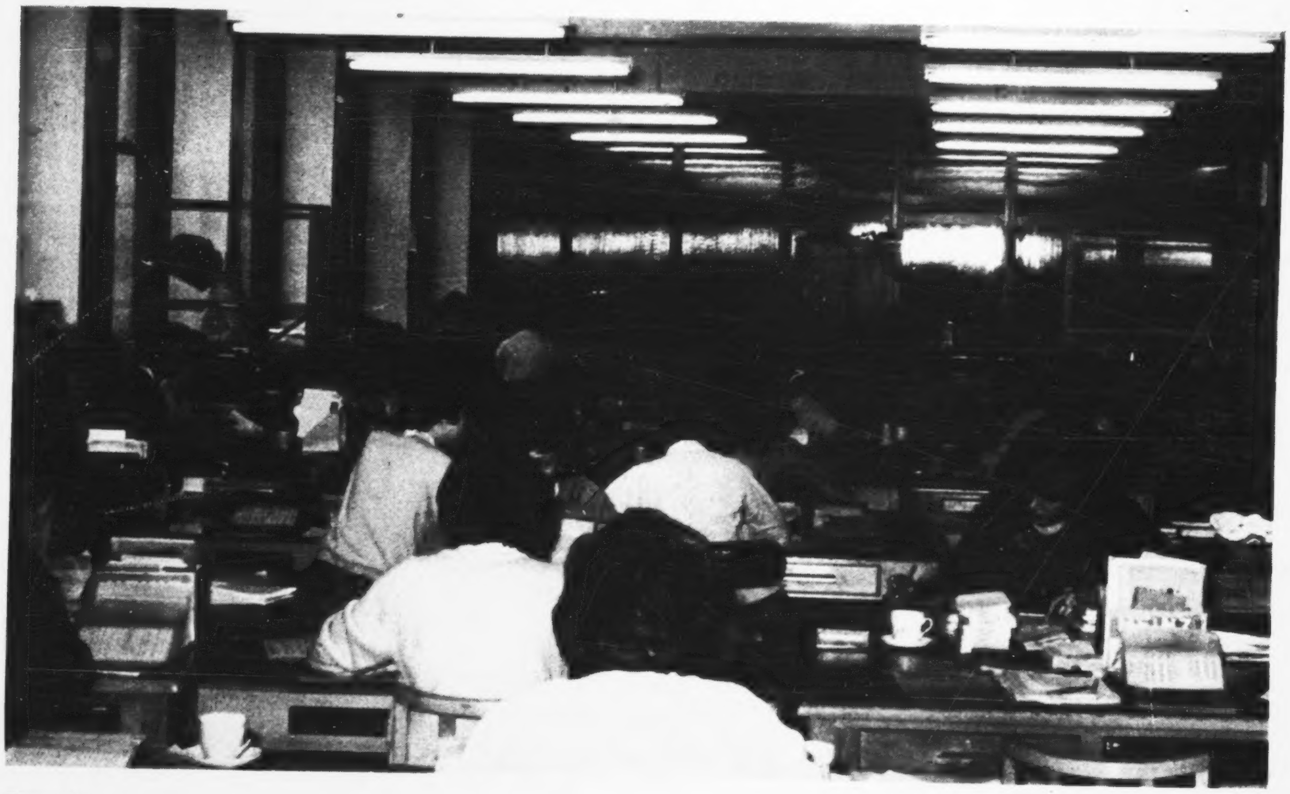

Figure 11
General office.

sheet. Occasionally some form of acoustic tile had been used on ceilings. Many different types of partition (standard systems and in-situ constructions) were seen. The services provided within the building contract were heating, and electricity for lighting and office machines. Telephones were added later, usually by arrangement between the occupier and telephone organisations.

Use of space

Most office space was used as a combination of open offices together with a number of small rooms accommodating one or two people. It was noticeable, however, that the larger the organisation and its floor space, the more marked was the tendency for bigger and more open offices to be used. At the other extreme, small organisations employing total office staffs of six or seven might accommodate them in three, four or five separate rooms.

Original planning decisions may exert a great deal of influence upon the way in which open office space is used. A number of buildings, for example, had been designed as long blocks or wings, with a total width of 40 to 50 feet. The office space in these was usually served by a central corridor and the depth of the room from the windows was a maximum of about 25 ft and frequently less than 20 ft. It was rare to see such offices more than 100 ft or so long. Small private offices partitioned off from large open offices were usually arranged on the building perimeter, ie, by the windows. Areas of usable office space (ie, in the case of tenants, rented area) varied from 61 to 182 sq.ft per person.

User requirements of office space

Each occupier was asked whether his firm's work made any special requirements of the office space. The main need was for general-purpose space and there was little demand for special provision for excessively large or heavy or noisy equipment or individual procedures.

The office managements were also asked what they considered to be important factors in the design of office space. Most firms said they had been looking for good working conditions. This sometimes meant low levels of noise but more often good lighting (by which they intended daylighting). The need for space which would be readily adaptable to new layouts was mentioned; one firm chose their present offices because the standards of finishes and fittings in that building were reasonably good, while in alternative buildings they were 'cheap and nasty'.

Spatial standards

Only a few large firms had an established policy for determining their office standards. Where such standards had been fixed the minimum area was of the order of 60 sq.ft per person. A feeling was often expressed that the heights of office spaces were inadequate nowadays: for example, 9 ft was sometimes held to be too low. The structural design of floors often dictated the layout of an office because of the need to locate banks of filing cabinets over beams.

Working hours

The earliest time any of the firms which were visited started work was 0815, and the latest time any firm normally finished was 1800. Most started at 0900 and fin-

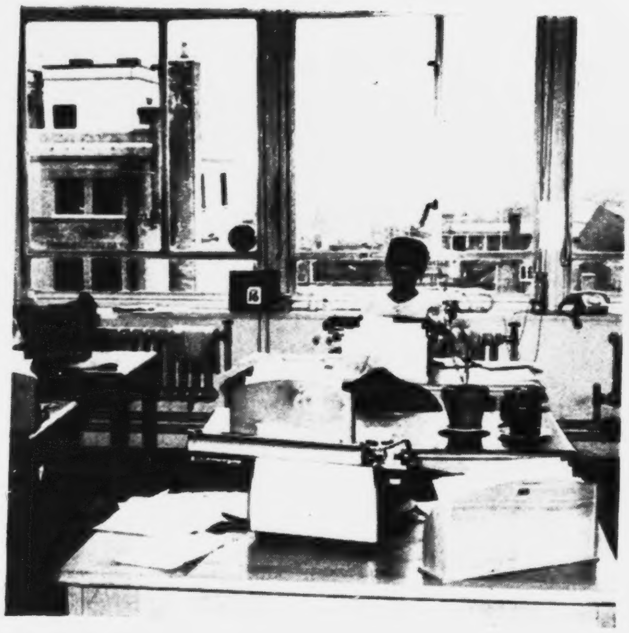

Figure 12
Most firms equate good working conditions with the provision of daylight.

Figure 13
Standard of finishes and fittings influences choice of offices.

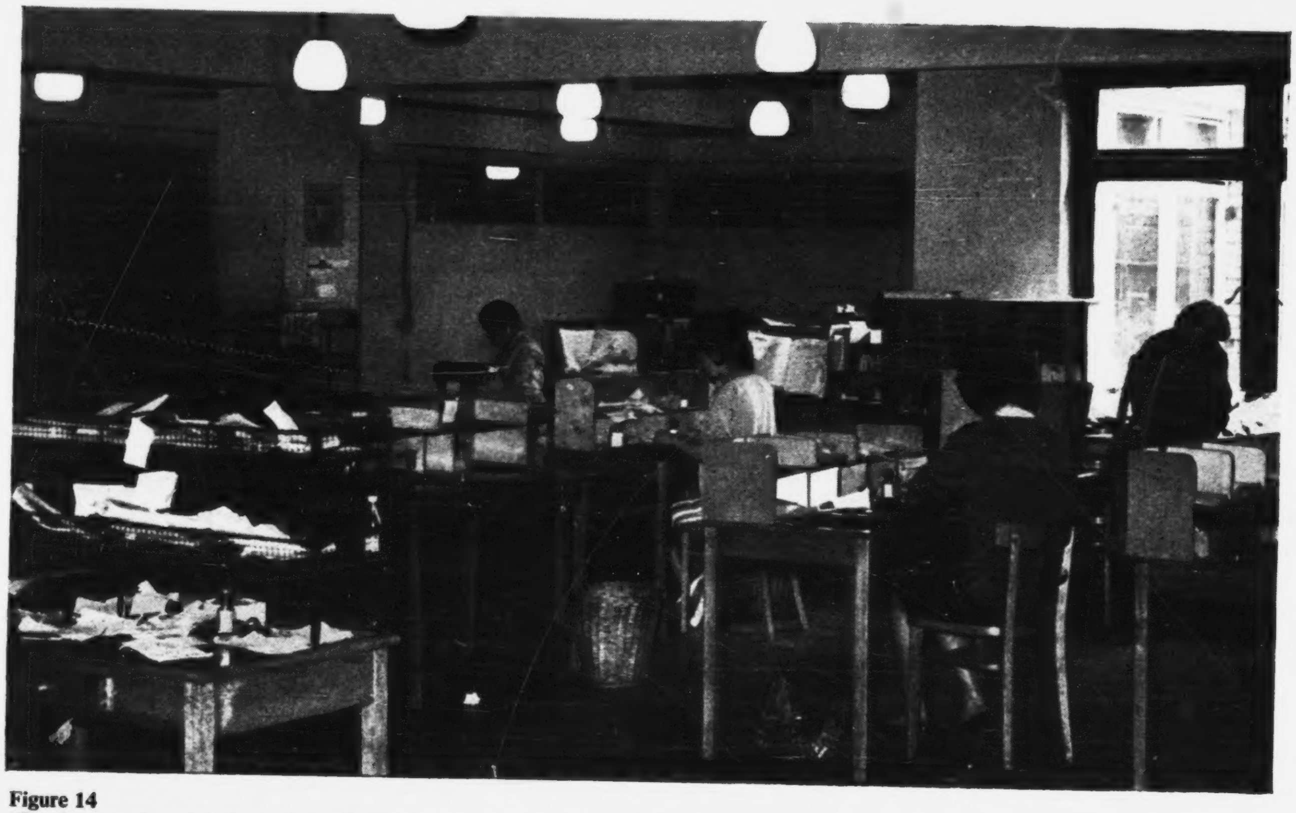

Figure 14
'Core' area of a slab-type plan office block with intersecting wings

ished at either 1700 or 1730. Rented office space within an office building was often available to the tenants only during normal working hours; without special (and possibly expensive) arrangements it might not be possible to enter a building before 0800 or enter or leave after 1900 hours.

Lighting
Almost all managements assumed that good daylight was an essential requirement for their offices, but few appeared to be very critical of the widely varying standards they had. In broad terms, there seemed to be three types of plan arrangement of general office space in relation to lighting:

(i) Long narrow rooms with windows on one side and a typical maximum depth of 3 desks arranged at right angles to the windows.

(ii) Large open areas with moderate to good electric lighting; people not on the perimeter were working partly or mainly by electric light, but they had some sort of a view to the outside.

(iii) Badly shaped spaces and ill-designed lighting installations; people were working in poor daylight conditions or with inadequate electric light, sometimes without a view outside.

It is obvious that some electric light will always be used during office working hours in categories (ii) and (iii). Offices with the arrangements described in category (i) normally expect to work without electric light, (especially during the summer months) although, in practice, it was not unusual to find that electric lights were being used. But this could be due to a number of factors, including window design, weather condition and time of year. Many offices in city centres, particularly those on lower floors, are seriously overshadowed, so that any daylight received at points more than two or three feet from the window is indirect, being reflected from buildings opposite.

In some large organisations it seems to be tacitly accepted that clerical staff should not work except in daylight

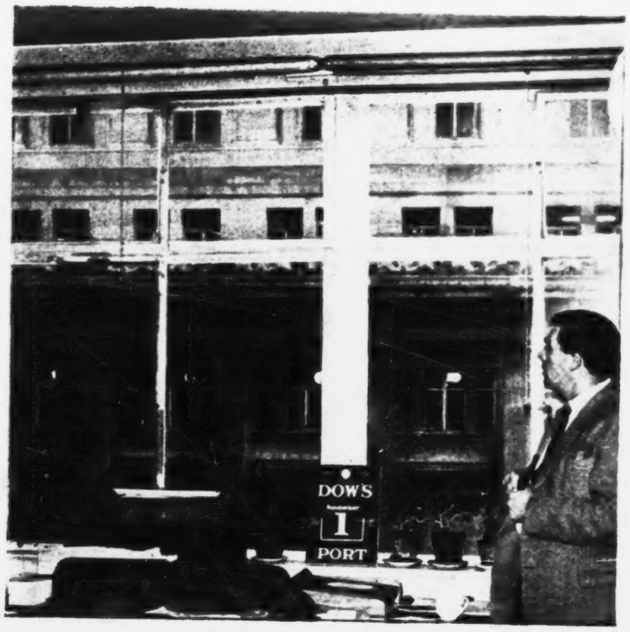

Figure 15
Indirect daylight.

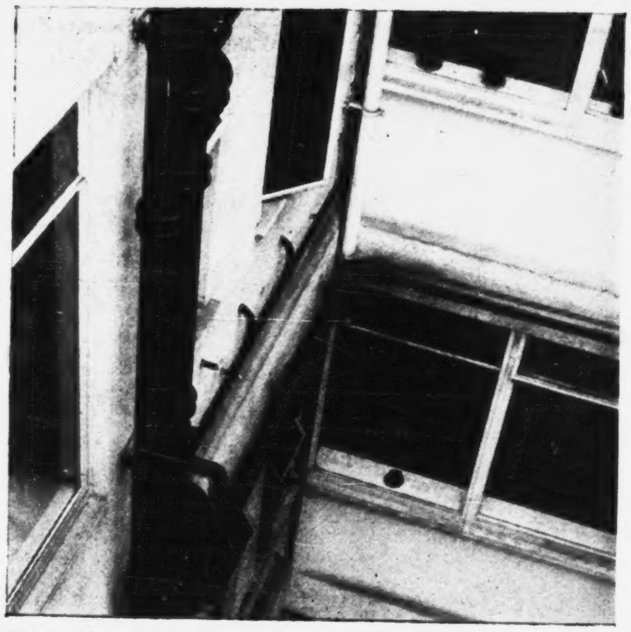

Figure 16
Internal light well.

(ie, within about 10 to 15 ft of a window) and it seems likely that this attitude influences the design of the buildings which these organisations rent or build. Several post-war buildings contained internal light wells which were lined with white or glazed bricks which had become dirty and were patterned with drain pipes. Invariably they looked depressingly dingy, yet the managements seemed certain that although their staffs would prefer an external wall to an area wall, the area was acceptable in a way that total reliance upon electric light would not have been.

On the whole, people appeared to like working fairly high up in buildings (eg, 8 to 10 storeys high or higher) because of the better opportunity for daylight and a view, and of being away from street noises. Venetian blinds, sun blinds or curtains were usually fixed after the building contract had been completed and when their necessity had become apparent. In the upper floors of the very high buildings the view from the working position was onto very bright sky. The views from the lower floors were more likely to be of other buildings.

A majority of the offices used tubular fluorescent lighting.

Heating and ventilation

The principal difficulties concerned with heating and ventilation in offices seemed to arise from the different thermal requirements of different individuals. Differences of attitude to the thermal environment between men and women, and young and old may be expected, but people of the same age and sex, working together, may complain of completely different conditions (eg, draughts and stuffy atmospheres) at the same time. Of all the environmental problems this seems to be the one of which office managers are most aware and which they find most intractable. The problem may at times be extreme. To avoid disputes as to whether windows should be open or closed, one manager had instructed his porter to go round the building opening all windows for five minutes in each hour.[41] This building received more fresh air than most, for, typically, the offices which were visited during the period July to November had almost all their windows shut tight.

Practically all of the offices which were visited were heated by radiators placed under the windows. Where private offices were partitioned off from an open space it was not unusual for thermal conditions in the small rooms and the main spaces to be quite noticeably different. On several occasions office managements mentioned the need for heating systems to be subject to greater and more local control. In a number of buildings noticeable differences in air temperature were reported to occur between the upper and lower floors (the upper floors being the colder ones) and between rooms on the north and south sides.

Thermal conditions in summer

Several firms reported uncomfortably hot conditions during summer, but the principal form of discomfort during this time of the year seemed to be caused by glare. It was, however, difficult to assess the importance of this issue for response may be largely dependent upon recent conditions and the summer of 1962 (when these preliminary visits were made) was not a noticeably hot one.

Noise

Where offices are sited fronting onto busy main shopping streets or traffic routes, disturbance from outside noise can be substantial. The noise level can be reduced by closing all windows but this presents the office workers with a choice of reducing the noise level and having to suffer a stuffy atmosphere, or of ventilating their rooms and accepting the noise. The usual course is to keep windows closed. Some of the offices in the sample which were located in shopping areas had to contend with canned music from the shops beneath.

Internal noises seemed to be relatively unimportant, even in large open offices, although one organisation explained its use of small rooms on the grounds that they limited the number of people distracted by telephone calls. In small offices shared by an executive and his secretary the typewriter could not be used during a conversation on a telephone or with a visitor. Most large office organisations had machine sections, but these were usually partitioned off from normal clerical offices.

Construction work was a common cause of complaints of noise, particularly in the early days of a building's life when some parts were undergoing preparations for a new tenancy, and the noise created – especially that transmitted through the structure – annoyed tenants already established. Heavy footfalls from public corridors and even from floors above were often audible.

In most private offices where an adequate degree of privacy was considered necessary, the requirements were met, but in some small offices it was often possible to be aware of telephone conversations in adjoining rooms.

General comments by managements upon office design

Many views were expressed by different managements which, while not of direct interest to this project, provided an insight into related problems of office design.

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[41] This is a practice which at one time may have been general in the civil service: see **Study Group appointed by H.M. Treasury:** op cit (25)

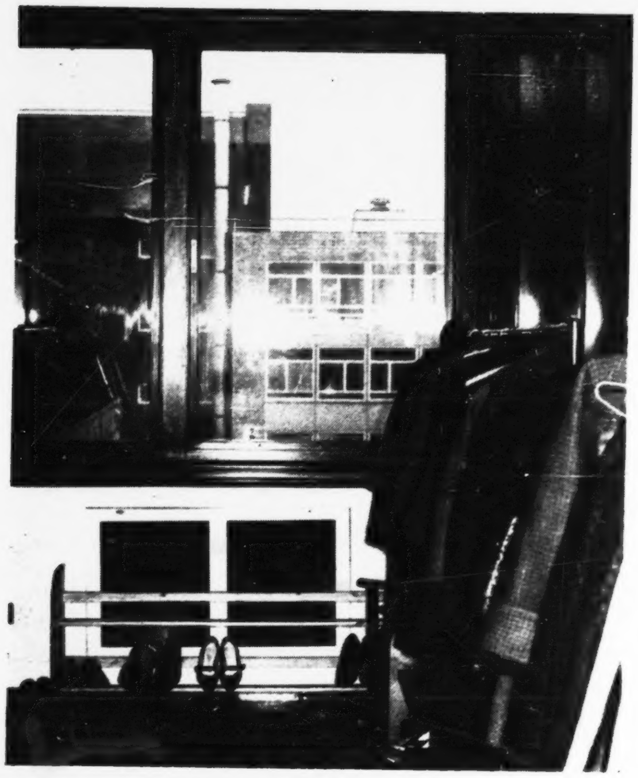

Figure 17
Space needed for staff's clothing.

Toilets were often thought to be too few in number and their users were critical of the standards of the surface finish and equipment provided. The frequently used plan arrangement of lavatories for different sexes on alternate floors was highly unpopular. Some building owners were caused considerable expense by wilful damage to lifts and toilets. Complaints were also made about the unreliable or temperamental nature of lifts and the noise they may create. A small room where staff can eat sandwiches and make tea was usually considered an essential provision. Opportunity to rent a car-parking space within the building was often appreciated, but cost at least £100 per annum and sometimes a great deal more.

The cost of using office space

With such a small sample, it was not possible to obtain any useful data on the typical costs of constructing office space.[42] An indication of the annual costs per sq.ft incurred by tenants of rented space are given in table 2. The figures quoted are 'typical' rates which were in force in Liverpool in mid 1962. There were, of course, considerable variations between firms, depending on the date of lease, type of office, the tenant, and other factors.

Table 2
Typical annual costs incurred by tenants of office space in Liverpool during 1962

	Cost shillings/ sq.ft	Percent of total
	in the region of	
Rent	10.5	46
Service charge (to cover heating, lifts, lavatories, etc.)	2.5	11
Rates	7.5	33
Electricity	0.5	2
Cleaning – of rooms *	1.5	7
– of windows	0.3	1
Insurance	(not known)	–
Redecoration and maintenance (average per year)	0.05	–
Total (excluding insurance) say	23.0	100

*Costs of room cleaning were not obtained but '. . . cleaning costs . . . may normally be reckoned at 1.5 to 2.0 shillings per sq.ft of floor area per year' (**Eastwick-Field, J. C:** Finishes. J Royal Inst Brit Archt, 1957 (July)).

Taking the average density in these offices as 120 sq. ft. per person, the annual costs were of the order of £140

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[42] But a summary of the illustrated cost analyses of office buildings which have been published from time to time in the Architects' Journal is given in appendix 3.1. See also: **Imperial Chemical Industries Ltd:** Standards for offices and laboratories. (The Company), 1960 (April)

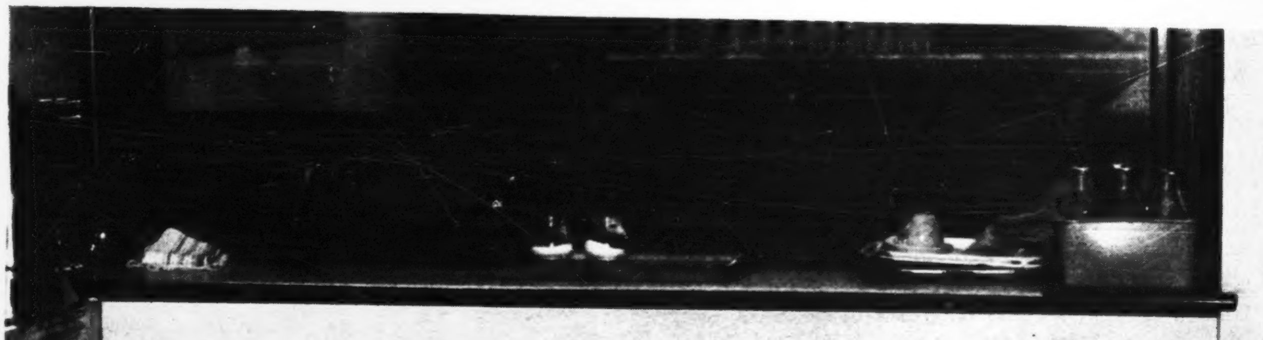

Figure 18
Staff tea room.

per office-worker.[43] On first moving into an office, tenants might be faced with the expense of providing partitions, floor finishes, light fittings etc. Figures obtained from firms which had had to carry out such work varied between 7.0 and 30.0 shillings/sq.ft.

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[43] These are the 'typical' costs in one provincial city. Costs elsewhere, especially in London, could be very different

Chapter 4
The external environment

and the location of post-war office buildings

A large part of the environment within a building results from the wider environment outside, which is modified by the building's fabric and services. The nature of the external environment depends in the first place upon the building's geographical location: whether, for example, it is in the north or south of England, in a city centre or a suburb. It is influenced also by factors of the micro-location such as the micro-climate; the congestion, noise and fumes of traffic; the land-use of surrounding areas and by more abstract local characteristics. All these features of the external environment of office buildings require further investigation.

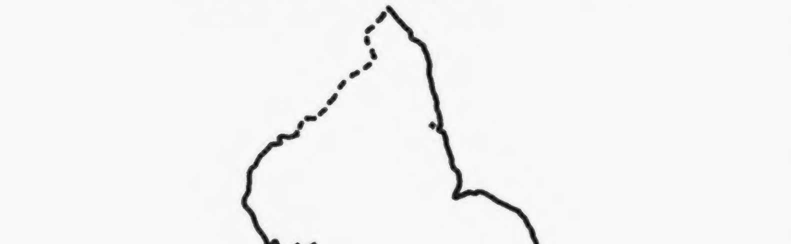

Figure 19
Geographical distribution of post-war office construction (built or under construction). The small circle within the large one representing London shows office construction in Croydon to the value of nearly 3 million sq. ft. (See appendix 5.1 for actual amounts).

The Unit's location enquiry developed from part of a larger enquiry into the statistics and general characteristics of this building type, for details of the office buildings constructed in this country had not been collected by any central agency and they were necessary for sampling purposes.

The enquiry commenced in July 1962, when every planning authority in England and Wales was circulated and asked for the total amount of new office space built since 1945, the number of individual projects and, for each project, the floor area, number of storeys, location, ownership and cost of construction. Of 145 planning authorities asked, 65 percent gave some information. 27 percent replied that they had neither the information available nor the time and staff to collect it; the remainder did not reply.

Unless an authority had already maintained a separate register of applications for planning approval for office development there were formidable problems in complying with the request, and it is not surprising that such a large proportion of planning authorities have been unable to help. Councils which have replied have done so in varying amounts of detail: in respect of the whole area of some towns, only the central areas of others, only the major buildings elsewhere, and all for different periods of time.[1] Analysis of the replies has consequently been extremely difficult but the best available estimate is that in England and Wales something of the order of 120 million sq.ft of office building has received town planning approval since the end of the war. Of this figure, about 80 percent is in the south-east of England.

By 1962 about 50 million sq.ft of the total approved had been built or was under construction in London itself and a further 8 million or so in the Metropolitan parts of Essex, Hertfordshire, Kent, Middlesex and Surrey and in the county boroughs of Croydon and West Ham. Other county boroughs in the South-east in which significant areas of office space had been built were Reading and Southend (0.6 million sq.ft each). In the eight new towns surrounding London 1.5 million sq.ft had been built or was under construction, Hemel Hempstead having the most with 0.4 million sq.ft.

The remaining 20 percent of office space which had received planning approval was distributed about the whole of England and Wales outside the South-east. Of the total approved in the provinces, rather more than three-quarters (18.4 million sq.ft) had already been built or was under construction. 11.7 million sq.ft were located in seven of the towns and cities, ie, Birmingham (3.4 million sq.ft), Liverpool (2.2 million sq.ft), Manchester

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[1] See appendix 4.1

(1.9 million sq.ft), Bristol (2.2 million sq.ft), Cardiff (0.8 million sq.ft), and Leeds and Derby (each about 0.6 million sq.ft). Most of the towns with between 0.2 and 0.5 million sq.ft of post-war office space were located in the North and Midlands, but two (Plymouth and Southhampton) were on the south coast. Apart from Newcastle, towns in the North-east reported very little office building.

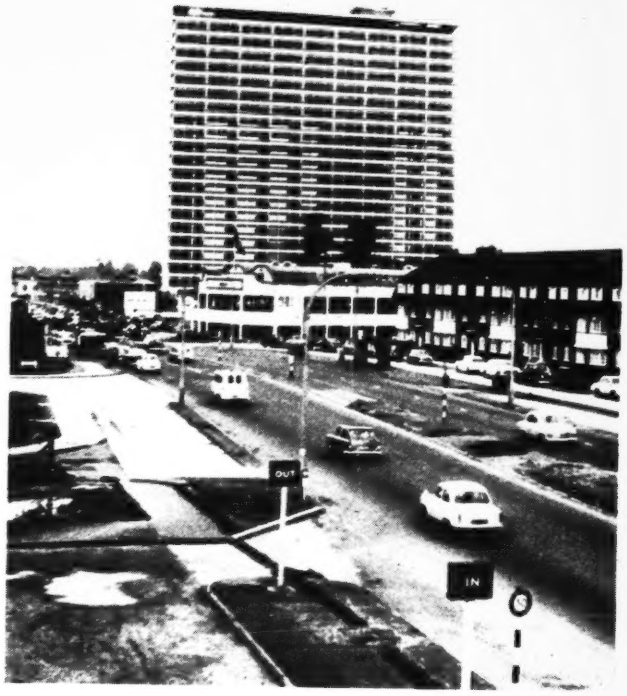

Figure 20
New office building in London suburb

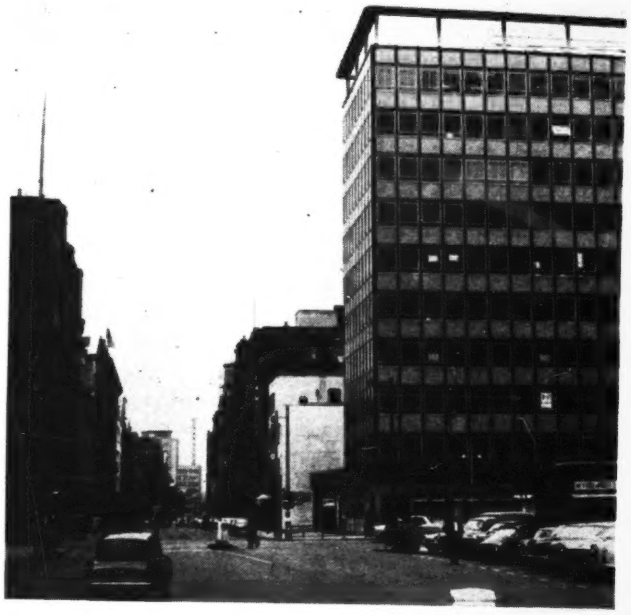

Figure 21
Most post war offices have been built in city centres.

Information from the county council areas outside the South-east has been sparse. The indications from Cheshire and Staffordshire (which between them had a minimum of 1.6 million sq.ft approved) were that there may have been a fair amount of office building in the county areas of the West-midlands. This may also be true of the county areas (particularly their industrial parts) of Lancashire, Yorkshire and Durham. Monmouthshire had approved over 0.6 million sq.ft but the largest figure approved by any of the other five Welsh counties which replied was only 50,000 sq.ft.

The outstanding fact which emerged from the survey was the high concentration of new office building in London and the south-east of England. This has been due to several reasons, but firstly the need to replace buildings damaged in the war and secondly, to accommodate the increasing demand for office space. This demand has been created by the 'drift' of population to the South-east in the last three decades and by the desire of many firms to establish the prestige symbol of a London branch or headquarters.

The tremendous expansion of office construction in the South-east has caused serious concern in official circles for the 'formidable transport, housing and financial problems in its wake . . .', the effect of these problems upon the lives of Londoners,[2] and the depressing effect of the population migration upon the regions.[3]

A policy of dispersal from London has been advocated by the Town and Country Planning Association since at least 1958 and this was eventually adopted by the Conservative government, which stated its policy thus:[4] 'The Government intend to tackle the office problem in the following way:

(a) to make planning control over new office building still (*sic*) more effective	*(by modifying the rules which previously permitted re-developers to add 10 percent to the volume of the old buildings. With the aid of modern construction and planning techniques, this made it possible to add up to 40 percent to the effective floor area of rebuilding schemes)*
(b) to get as much government work done outside central London as possible	*(over three-quarters of the Civil Service already work in regional and local offices and the possibility of moving out a proportion of the 100,000 now remaining in London is to be considered)*
(c) to encourage the provision of more office centres outside the heart of London, including places right away from London	*(such as the new towns and other centres as distant as Norwich and Reading)*
(d) to make a major effort to dissuade private employers from opening new offices, or extending their present ones in central London; and to persuade employers already there to decentralise work which is not clearly tied to London'.	*(the principal instrument for this will be the Location of Offices Bureau (LOB) which has now been set up – in central London)*

By mid 1964, the main activities of the LOB had been:

(i) to commission an enquiry by the Economist Intelligence Unit into the reasons why companies have their offices where they do
(ii) to accumulate and act as a clearing house for information on possible re-location areas outside London
(iii) to propagandise the economic and other advantages of relocation.

The EIU study[5] has only recently been made available. It provides a great deal of information about companies' reasons for their present location, and their attitudes towards decentralisation. The principal reason given for location in central London was a need for contact with other organisations. But more than half of all the firms who gave information had, in fact, no need to be in London for that purpose. Other important reasons given for a central location were tradition, prestige, and ease of communication with the remainder of the country.

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[2] **Minister of Housing and Local Government:** London: Employment; housing; land. Cmnd 1952. HMSO, 1963 (February)

[3] Ministry of Labour figures for 1959-60 suggest that in that year the London Region gained about 40,000 insured employees from Scotland, the North of England and Wales (**Town and Country Planning Association:** The paper metropolis. (The Association) 1962)

[4] **Minister of Housing and Local Government:** op cit (2)

[5] **Economist Intelligence Unit:** A survey of factors governing the location of offices in the London area. (Location of Offices Bureau), 1964

It is difficult to assess the potential usefulness of LOB. The annual increase in the number of jobs in central London during recent years is believed to have been almost entirely in office employment and to have numbered at least 15,000.[6] So far, LOB has been able to influence the movement outwards, from the centre of London, of less than one-fifth of this number, and most of this only as far as the London suburbs.[7]

Although the evidence of the Unit's location enquiry is incomplete, it seems clear that the bulk of post-war office building has occurred in city centres, where the most severe environmental problems are likely to arise. Sites are expensive and therefore restricted in area; adjoining buildings overshadow; city centre traffic creates a continual noise problem; both access and car-parking are likely to be difficult. The office buildings in which the more detailed surveys of the Unit's environmental study have been made have, with one exception, been offices on such sites, with difficulties similar to the ones described. The exception, an extensive single-storey open-plan office which is located in a suburb of a large city was included because it provides an interesting alternative to the type of building necessitated by city centre development and one which the mounting pressures to decentralise may make more common.

During the preliminary visits, office managements were asked why they had decided to take space in their present buildings. The answers naturally ranged widely but one or two recurred frequently. One was that, at the time a move to a new building was contemplated, the building in which the offices were now located was the only one with suitable space available. Situation was probably the most important single criterion: central location within or accessible to the commercial centre of the city or other business foci was a general requirement. Many businesses had been located near railway stations and main shopping centres because it had been thought that these features would attract staff. A few firms had considered moving to the suburbs but had been deterred by possible difficulties in persuading office staff to follow; a small number of market surveys by individual firms had confirmed that these difficulties might be real.

The economic implications of a decision to locate an office or to rent space in a particular situation can be substantial. LOB has calculated, for example,[8] that each office worker in central London may cost his employers £275 p.a. more than one outside. Of this total the higher rent of office space amounts to £180, higher rates on office space £45, and the central London salary differential £50.

The traditional pattern for the planning of the business areas of British cities consisted of 'corridors' of buildings facing each other across the street. By its very nature this plan can be expected to create environmental problems. Daylight, especially on the lower floors of buildings, is likely to be obstructed and a canyon is created for sound to reverberate within. The London County Council operated a 'Daylight Code'[9] which essentially consisted of angular limits in plan and section governing the bulk of the building. This superseded the previous (and elsewhere more general) control by cut-off angles and set-backs and was conceived as permitting a greater variety in the form and layout of new buildings whilst ensuring that they and their neighbours obtained better daylighting. In practice the Code does not appear to have been as successful as was hoped. Building-lined streets have sometimes been avoided, and some buildings have suffered less obstruction than they might otherwise have received. But it seems possible that tower buildings which have been permitted have created as many problems as they have solved: they are exposed to the noise from more than one street and, in some cities (perhaps especially in London) they have created major visual and aesthetic problems.

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[6] **Town and Country Planning Association:** op cit (3)

[7] This was written in 1964

[8] **Town and Country Planning Association:** Planning Bulletin: quoting *The Guardian*, 1963 (October 1)

[9] **Ministry of Town and Country Planning:** Redevelopment of Central Areas. HMSO, 1947. See also: **Crompton, D. H:** The daylight code. Town Planning Review, 1955 (October)

Chapter 5
The spatial environment

The basic criterion of space in an office building is that there must be enough for the satisfactory performance of the work. In a narrow interpretation of building economy a standard of just enough is the efficiency level; in practice, minimum standards are rarely found and there is a general expectation of additional space. Minimum space is regarded as mean; more space than is functionally demanded contributes to enhanced quality and usually confers status to buildings, rooms, their occupants and even the work. This aesthetic value of extra space applies throughout a building, to stairways as well as offices, to lavatories as to conference rooms. The spatial criteria to be applied to a building will depend, therefore, upon many factors, including the location and purpose of the building, its place in the hierarchy of its users and the status of the occupants. The owner of a prestige office building will be prepared to accept (and will in fact expect) a lower ratio of usable office space to total floor area of building than will the owner of, say, a works office. For the same reasons, a managing director will be provided with several times more floor area than a typist. It is therefore difficult, if not impossible, to define spatial standards. What can be done is to state generalisations which are applicable to both office buildings and office spaces, eg:

(i) whatever the quality level of the office (building or room) there must be sufficient space for adequate functional performance of the work. Any space additional to this basic requirement must contribute to increased aesthetic value and, if possible, increased functional efficiency

(ii) the building fabric (eg, the structural frame) should be subservient to the office space, and should not detract from the functional, economic or aesthetic value of this space.

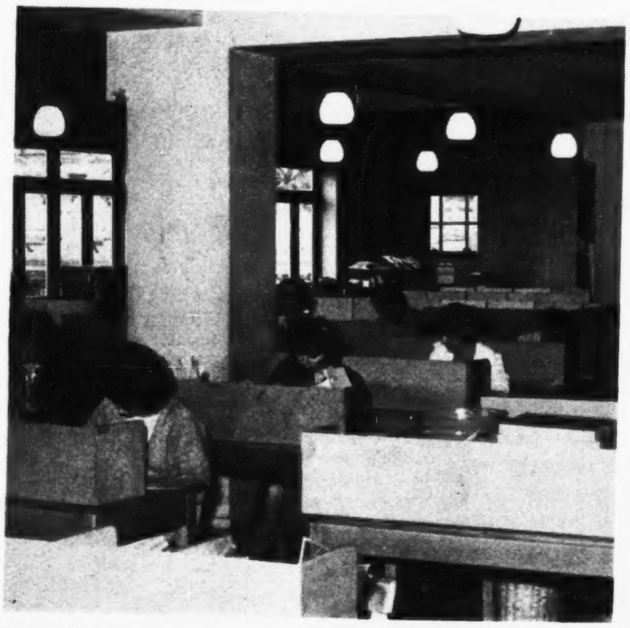

Figure 22
Structural column occurring within working space.

Legislation

The unit of space in an office is the amount needed by individual office workers, or by a particular office-process. Recent legislation[1] requires that, except in the case of rooms to which members of the public have access, floor areas should not be less than 40 sq.ft or room volumes less than 400 cu.ft per person. These requirements will become effective in 1967, ie, three years after the vesting date. There is a general requirement that while work is going on no room may be so overcrowded as to cause risk of injury to health, and consideration must be given not only to the number of people who may be expected to be working in the room at any time, but also to the space occupied by furniture, fittings, machinery, etc. There will be few cases of modern office buildings being occupied at such high densities.

Previous surveys of the spatial environment in offices

The Civil Service study[2] drew attention to a minimum space per worker being dependent on standards of ventilation which would avoid air stagnation and body odours. To provide the 1,000 to 1,200 cu.ft of air per person per hour considered necessary dictated 400 cu.ft of space per person, assuming that 3 air changes per hour were obtained. Above this minimum, space standards were seen to be affected by, among other things, the shape of rooms, the demands of natural lighting, furniture and the status of both a room's occupants and their work. During wartime the general range of space provision in the civil service (including space occupied by furniture) was about 50 to 100 sq.ft per person. The report recommended 'comparatively large aggregations' of staff rather than small groups. Standards of 60 sq.ft per clerical worker and 40 sq.ft per typist were thought to be 'not unreasonable' where little filing and interviewing was done.

The office lighting survey's analysis[3] showed that for all types of employment the number of workers per room was most typically between two and four. At 61 to 80 sq.ft per person for the modal group and a substantial proportion (28 percent) of over 100 sq.ft per person, standards in national and local government were higher than in manufacturing industry where the comparable space allowance was 41 to 60 sq.ft.

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[1] Offices, Shops and Railway Premises Act 1963. HMSO

[2] **Study Group appointed by H.M. Treasury:** Working conditions in the Civil Service. HMSO, 1947

[3] **Gray, P. G. and Corlett, T:** A survey of lighting in offices. Appendix to Post-war building studies no. 30. HMSO, 1952

In Liverpool, gross overcrowding does not seem to have been general. A survey made in 1955 (and reported in 1958)[4] showed that thirteen rooms out of an unstated total in 136 buildings were considered to be overcrowded (by Gowers Report[5] standards of 400 cu.ft per person including the space occupied by furniture). A report published in 1959 of a survey made the previous year,[6] noted that overcrowding in many small rooms was due to the space occupied by equipment but mentioned only two rooms, out of an unstated total (used by 269 businesses in 47 buildings) where space standards fell below the Gowers minimum.

Space was measured but not reported upon in the Barrow-in-Furness survey.[7] In the City of London[8] only 7½ percent of rooms fell below the Gowers space standards while nearly 75 percent had over one and a half times that minimum; overcrowding was as likely to occur in post-war as in pre-war buildings.

Space standards

Apart from legal minima, the space standards of office workers will depend upon such considerations as:

(i) the policy of the organisation
(ii) the status of the office within the organisation's hierarchy
(iii) the status of the individual
(iv) the type of office space in which the work is to be done (eg, single private office, open-plan general office)
(v) the furniture and equipment to be accommodated
(vi) the needs of the individual or his work for quiet or privacy
(vii) the space available (which in turn may be influenced by projected expansion or change in the work).

The space allotments for different categories of staff in Imperial Chemical Industries Limited and the Civil Service have been published.[12] Enquiries addressed to several other large business organisations about their spatial standards for different grades of employee produced two additional lists. These are compared with the already published lists in table 3.

Table 3
Space standards adopted by certain organisations

(square feet per person)

Civil Service austerity standard 1948 (may still be in force)		Civil Service long term standards 1955 (now being applied to all new buildings)		ICI Ltd.		Firm X		Firm Y	
		Permanent Secretary	500 - 550						
		Deputy Secretary	400 - 450						
Permanent Secretary						Directors	350		
Deputy Secretary Under Secretary	200 - 250	Under Secretary	250 - 350	Grade A	290	Top executives	288	Directors	250
		Assistant Secretary	200 - 250			Senior executives	210	Senior executives	200
Assistant Secretary	150 - 200	Principal	150 - 200	„ B	170	Two senior secretaries sharing	210		
		SEO	120 - 150			One senior secretary	140		
		HEO	100 - 120					Managers	125
Principal	80 - 100	EO/HCO	75 - 90			Technical staff PA's Supervisors	100	Assistant managers	85
SEO HEO	60 - 80								
				„ C Supervisor	85	Secretaries Clerks Machine operators Typists	65 - 70		
EO / HCO	40 - 60	CO	55 - 65	„ D „ E Clerical	60				
CO	40 - 60							Secretaries	60
Typist	40 - 60	Typist	40 - 60	„ F Typist / clerical	50			Clerks	50

Sources: **Anon:** Better Offices. Institute of Directors, 1960, and PRU enquiries

The author of the mechanised offices report[9] considered that the most surprising conclusion to emerge from his examination of space was the relatively large amount of space needed for automatic data processing systems. The average in his eight buildings was 85 sq.ft per machine position; satisfaction with the space provided was only 45 percent among clerical workers, up to 58 percent among machine operators. The more recent paper from the Building Research Station[10] stated that for a 'satisfaction level' of 75 percent,[11] minimum space standards would be about 45 sq.ft for copy typists, 55 to 60 sq.ft for clerks and from 100 sq.ft upwards for senior management. Surveys in more than 2,500 office rooms showed that furniture occupies between 25 and 30 percent of the floor space.

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[4] **Wattleworth, W. H:** Unfinished business in environmental health. Royal Society of Health Journal, 1958 (May-June)

[5] **Home Office** and **Scottish Home Department:** Health, welfare and safety in non-industrial employment. Hours of employment of juveniles. Cmnd 7664. HMSO, 1949

[6] **Wattleworth, W. H:** The forgotten army. Royal Society of Health Journal, 1959 (March-April)

[7] **Nelson, I. D. M.** and **Morse, R. J:** A pilot study of office accommodation. The Medical Officer, 1960 (September 9)

[8] **Robinson, Alan:** Working in the city: the interim report of a survey. City of London Health Department, 1962

[9] **Langdon, F. J:** The design of mechanised offices. Architects Journal, 1963 (May 1 and 22)

[10] **Langdon, F. J.** and **Keighley, E. C:** User research in office design. Architects' Journal, 1964 (February 5)

[11] That is, the point at which, in nineteen cases out of twenty, seventy-five percent of the staff would be satisfied

[12] **Anon:** Better Offices. Institute of Directors, ?1960

Figure 23
Furniture: one of the factors which determine the standards of the spatial environment.

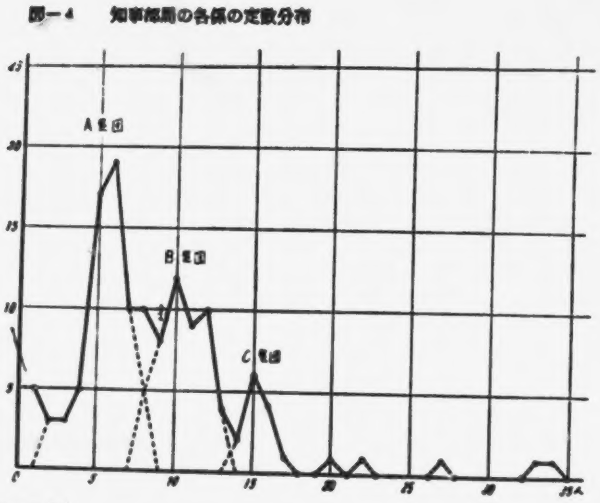

Figure 24
Frequency distribution by size of working groups in certain Japanese government offices (x = number of clerks in a group; y = number of groups).

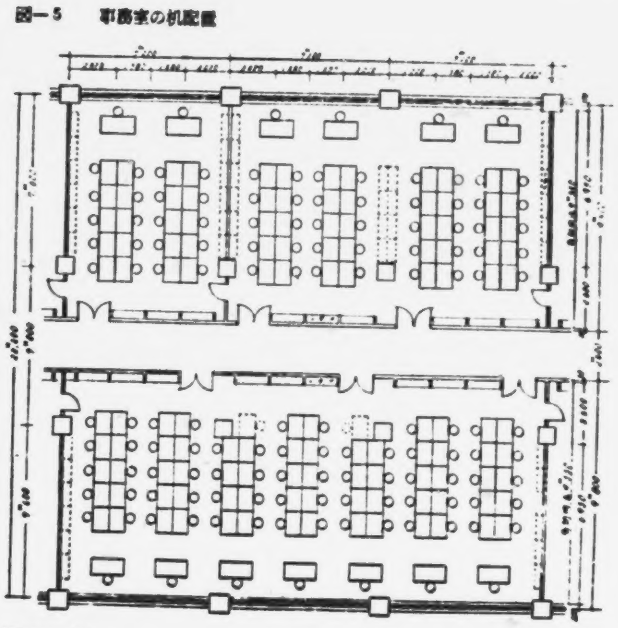

Figure 25
Design for Japanese government offices whose dimensions are determined by units comprising working groups of five clerks.

Spatial considerations in the planning of office space

The determination of space allowances and room dimensions appropriate to office functions has received negligible attention. One impression resulting from visits to office buildings has been that the basis for design seems to be quite arbitrary: office work appears to be fitted into whatever space is available, rather than the building being planned to facilitate office functions.

A seemingly obvious course would be to parallel industrial processes and design around the work-flow of paper. However, no studies of typical office clerical procedures which could be used to determine – or even help determine – office space are known. [13] Similarly, so far as can be seen, nobody in Europe has made any analysis of the size of working groups, or of the pattern of use of office space. Some of these matters have been investigated in Japan and, while the findings are almost certainly not applicable to British conditions, the precedent is a use-

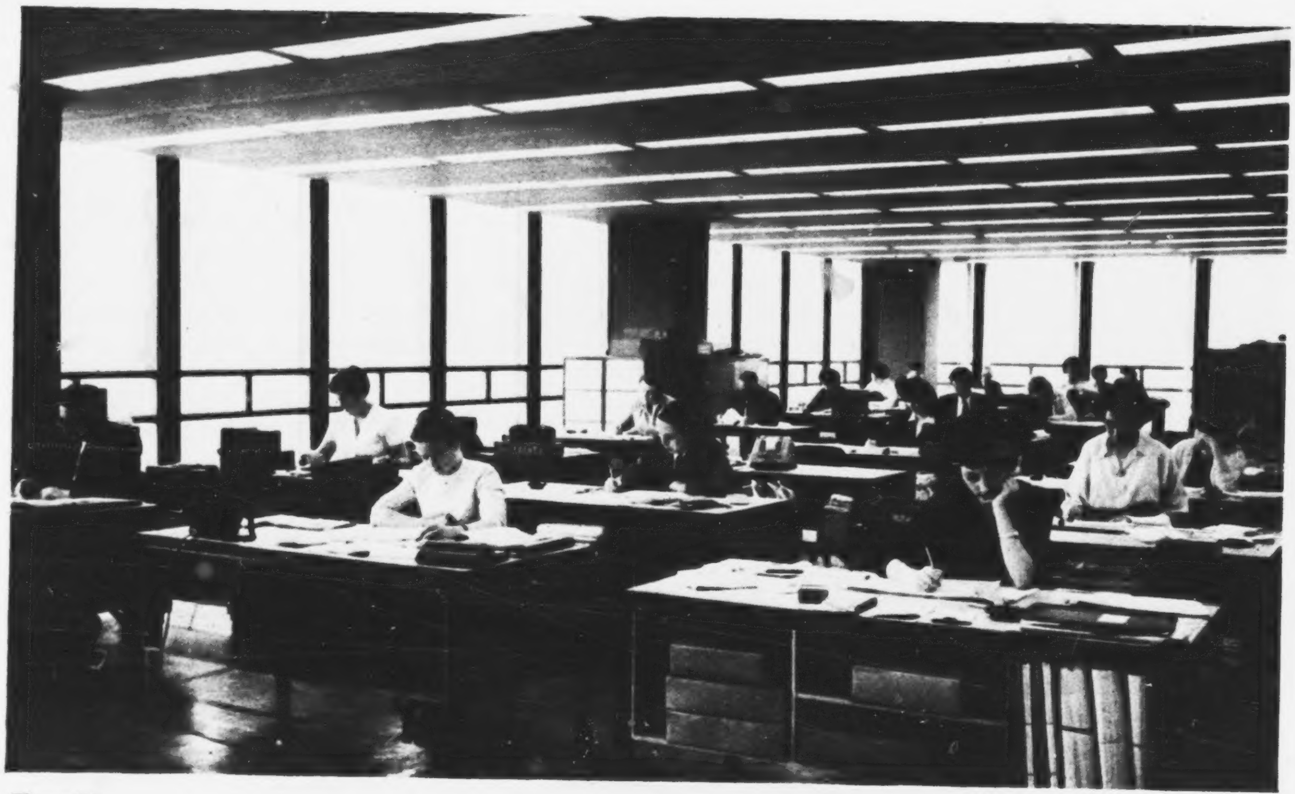

Figure 26
Typical arrangement of desks in a regular pattern.

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[13] 13. Apart from mechanised procedures. See **Langdon, F. J:** op cit (9)

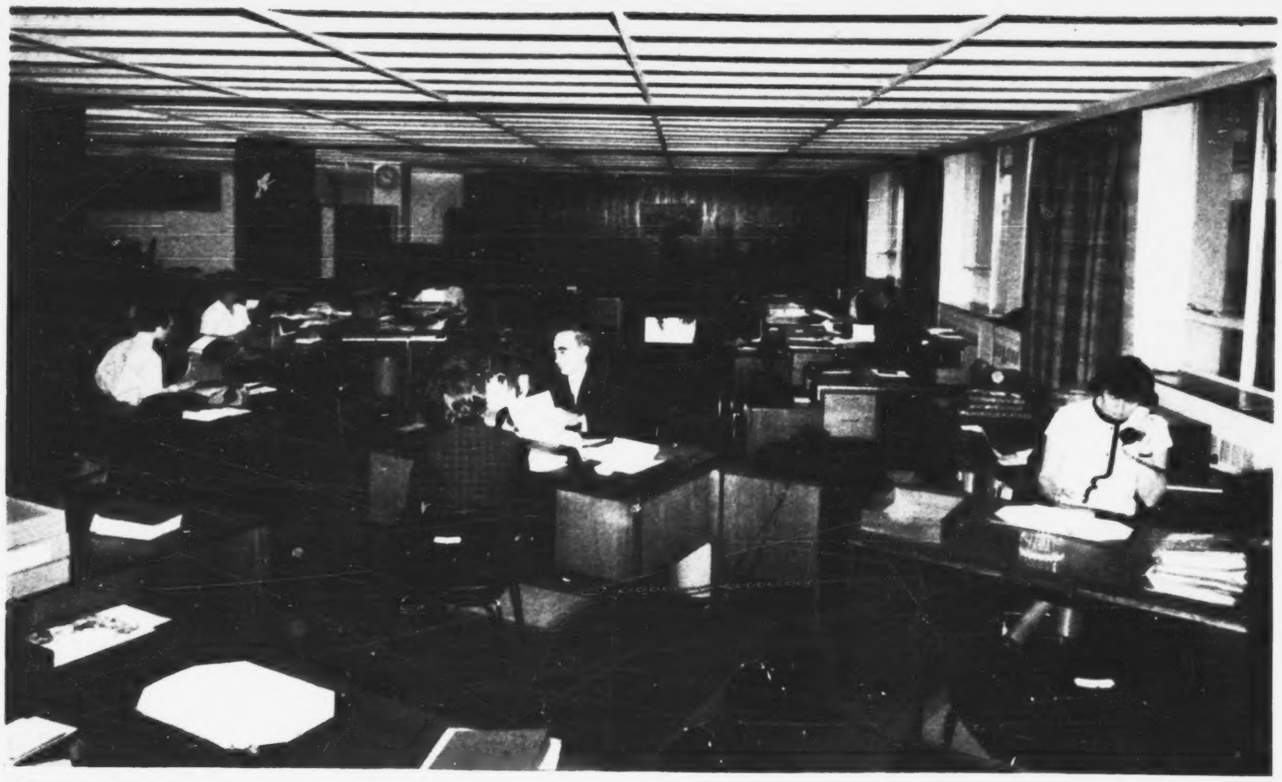

Figure 27
Bürolandschaft at British Petroleum Company.

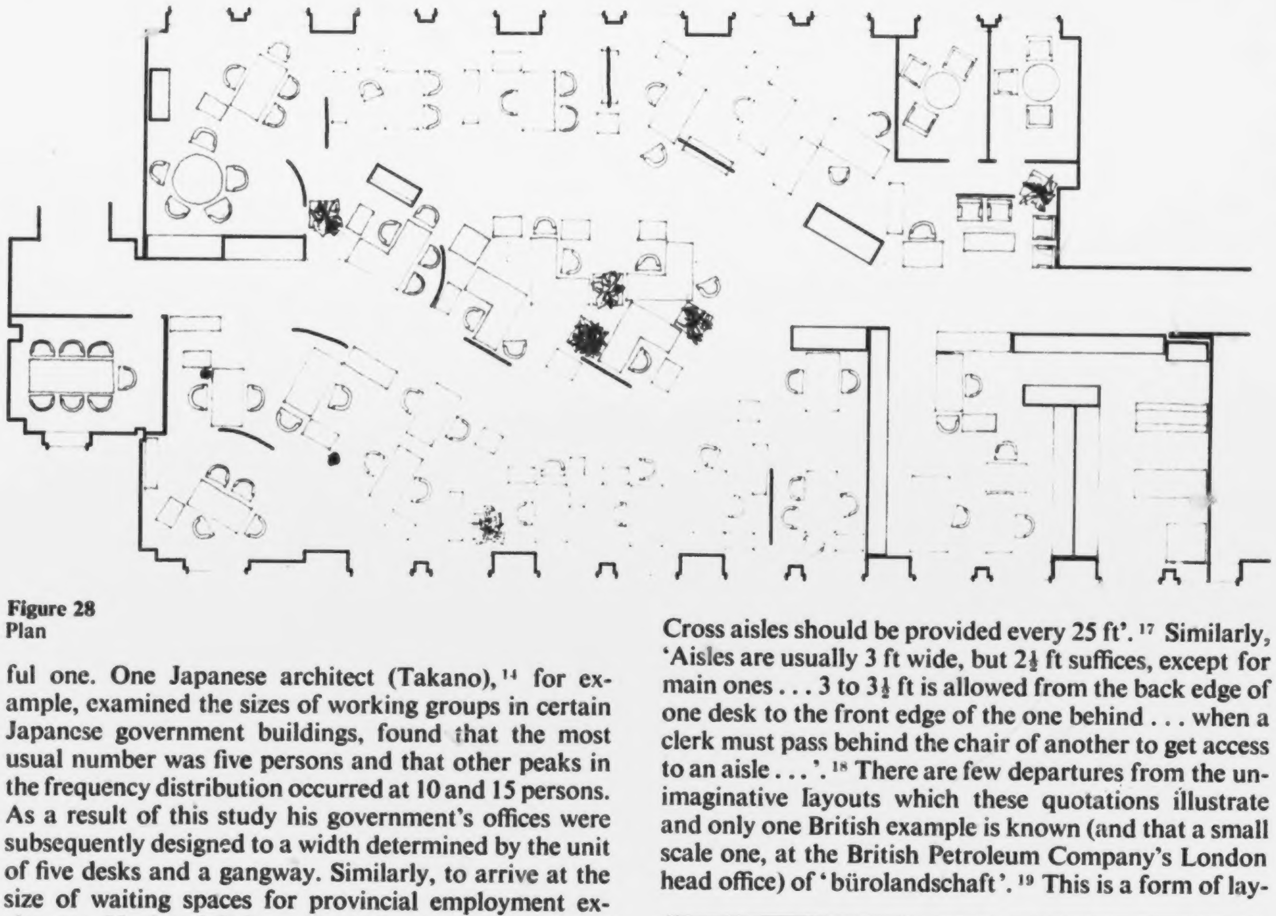

Figure 28
Plan

ful one. One Japanese architect (Takano),[14] for example, examined the sizes of working groups in certain Japanese government buildings, found that the most usual number was five persons and that other peaks in the frequency distribution occurred at 10 and 15 persons. As a result of this study his government's offices were subsequently designed to a width determined by the unit of five desks and a gangway. Similarly, to arrive at the size of waiting spaces for provincial employment exchanges, Yagi and Takano[15] made extensive studies of the manner of use of existing employment exchanges, including the 'customers' time of arrival and departure, the times they spent waiting and consulting and the number of people concerned. In respect of drawing offices, the relation of drawing board and reference tables has been systematised and the space utilisation of different arrangements shown,[16] but apart from the work on ADP systems already mentioned, the manner in which individual and grouped clerical workplaces are organised does not appear to have been studied.

Desks for clerical work are normally placed in rows: an office management handbook suggests that 'Main aisles should not be less than 4 ft, and sub-aisles 3 ft wide. Cross aisles should be provided every 25 ft'.[17] Similarly, 'Aisles are usually 3 ft wide, but 2½ ft suffices, except for main ones . . . 3 to 3½ ft is allowed from the back edge of one desk to the front edge of the one behind . . . when a clerk must pass behind the chair of another to get access to an aisle . . . '.[18] There are few departures from the unimaginative layouts which these quotations illustrate and only one British example is known (and that a small scale one, at the British Petroleum Company's London head office) of 'bürolandschaft'.[19] This is a form of lay-

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14. **Kensetsu-Shō Eizen-Kyoku Kenchiku-Ka** (Building Section, Building and Repairs Bureau, Ministry of Construction): Akita-Kenchōsha No Sekkei (The design of Akita prefectural government office). Kōkyo-Kenchiku (Public Buildings) ?1961 (in Japanese)
15. **Yagi, A.** and **Takano, T:** Chosa to Sekkei – PESO (Survey and design of Personnel Security Offices). Kokyo Kenchiku (Public Buildings) ?1960 (in Japanese)
16. **Langdon, F. J:** Design and equipment of drawing offices. Part 2, layout and equipment. Engineering, 1959 (April 24)
17. **British Institute of Management** and **Office Management Association:** Office accommodation. (The Institute, and the Association), 1953
18. **Curtis, C. R:** O and M in the smaller office. Part 4, planning the layout. Office Magazine, (now Office Methods and Machines) 1963 (March)
19. **Duffy, Francis:** Bürolandschaft. Archt Review, 1964 (Feb.)

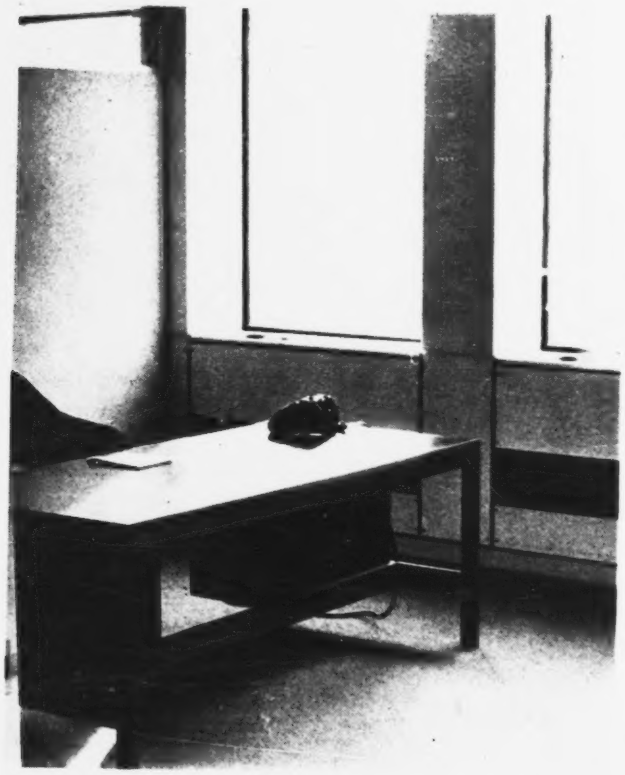

Figure 29
A single-person room forming a planning unit.

out in which desks and office equipment are clustered in functional and non-regular patterns within large open office spaces.

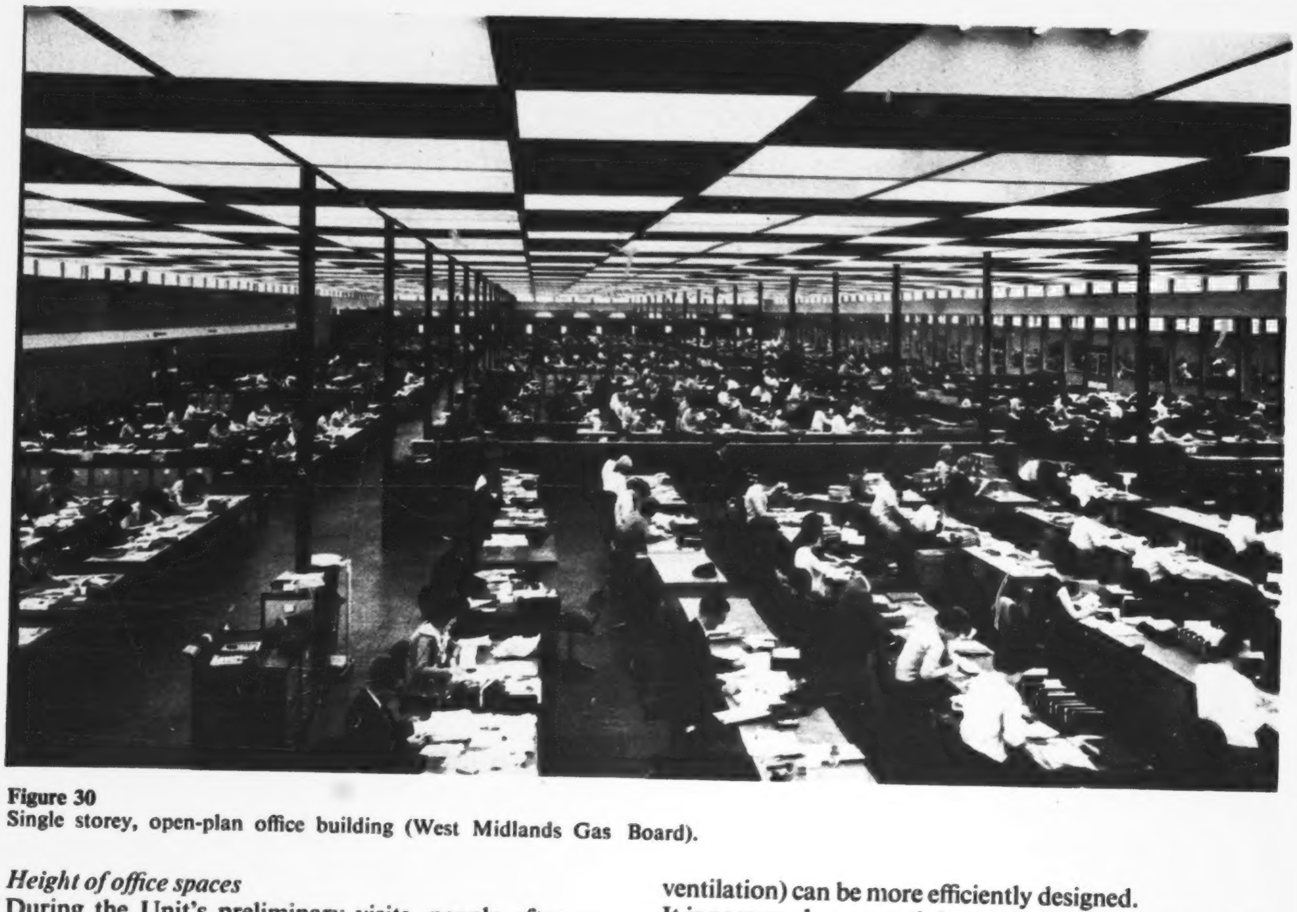

Figure 30
Single storey, open-plan office building (West Midlands Gas Board).

Height of office spaces
During the Unit's preliminary visits, people often expressed a desire for greater height in their office space, 'such as we had in our old building' (which was probably Victorian). What height should be provided does not appear to have received much consideration. The loftiness of many 19th century offices derived, most likely, from lighting needs: high windows were necessary to obtain sufficient daylight at the far side of large rooms. With modern developments in electric lighting this is no longer a valid reason for high ceilings. A survey of industrial laboratories has shown a clear correlation, in the case of that building type, between ceiling height and cost of building.[20] But there may still be some aesthetic justification for heights greater than the byelaw minimum, especially in large open offices, and this would have to be balanced with the economic and acoustic implications of increased height.

One factor which will affect sensations of room height is the amount of light playing upon the surface of the ceiling. Where light fittings are fixed flush with the ceiling, then the only light reaching that surface is reflected, mainly from the floor and desk tops. The effect is often rather gloomy. The floor to ceiling height of most office buildings constructed at the present time seems to be within the range of 9 to 11 ft.

The size of individual office spaces
Sizes of office spaces vary greatly, from the one-person room to the completely open floor accommodating several hundred people. This last form is very common in the U.S.A. and there are signs of it becoming more usual in Britain. The main determinants are the nature of the work and the policy of the organisation.

The use of 'open-plan' offices
It is possible that large open offices may often be more efficient workplaces than combinations of smaller spaces because of the opportunities they provide for easier supervision and communication. In addition, floor space can be used more intensively. Due to the reduction in circulation area, and the more efficient use of space which open planning permits, the space requirements per person in open offices are usually substantially less than in small rooms. Servicing also (eg, lighting and ventilation) can be more efficiently designed.

It is commonly expected that staff will choose to work in small units of space in preference to large ones. But managers, too, are likely to press for their staffs to be separated from those of other managers' by partitions, even though there may be no functional justification for separate rooms. A compromise can often be arranged by

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[20] **Hopkinson, R. G.** and **Longmore, J:** The use of permanent supplementary artificial lighting. Architects' Journal, 1959 (October 8). Figure 1 in this paper is derived from the work of the Nuffield Foundation, Division of Architectural Studies

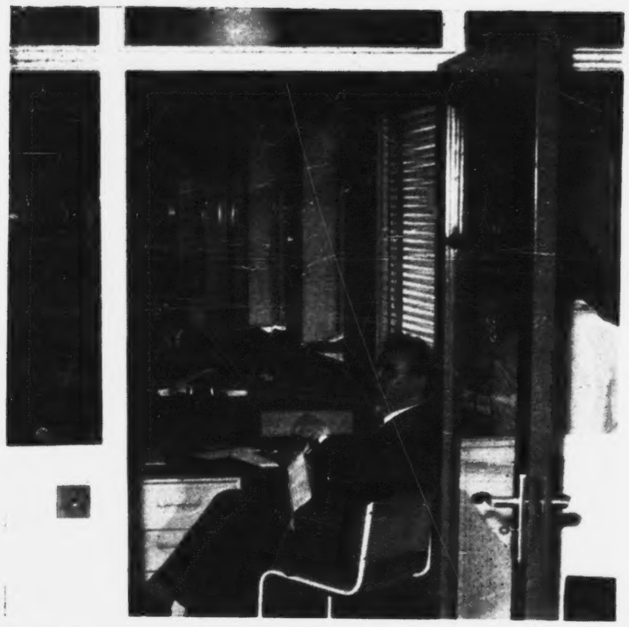

Figure 31
A group of offices separated by glazed screens.

providing partial screening, eg, by glazed partitions, isolated screens which define space but do not conceal, cupboards, filing cabinets and other office furniture. The output of noise from many office machines is frequently advanced as an argument against open offices. A common practice, and one which is often necessary, is to place machine staff and their equipment in rooms separate from those occupied by un-mechanised clerical staff. Interference from noise can be reduced in open offices by arranging that walls and partitions are as far apart as possible (ie, of the order of 50 to 60 ft [or more]) to reduce reflections, and by using acoustic ceilings placed as low as possible.[21]

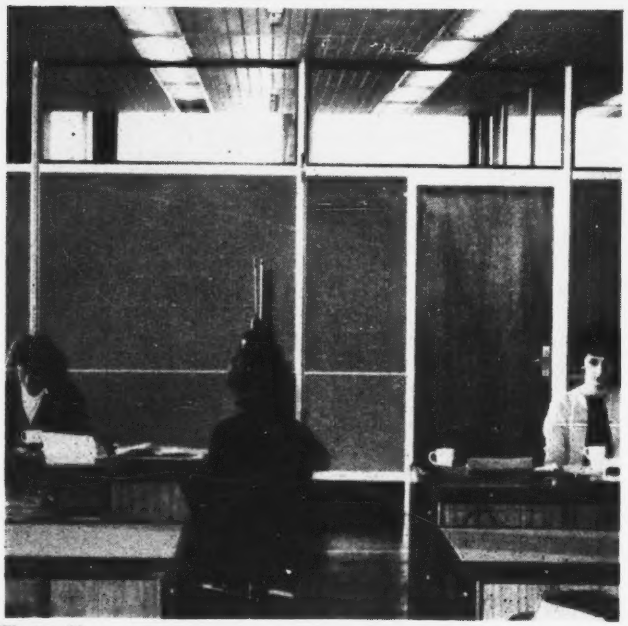

Figure 32
Demountable partitions.

The influence of room size on the members of working groups

It is possible that offices can be built to greater depths than has previously been supposed and still provide a satisfactory environment. However, the possibility of deeper buildings may be qualified by a probable importance of unobstructed views of windows, which suggests that in order to obtain the advantage of deep buildings, it may also be necessary to accept open working areas.

Office staffs' possible preference for small offices or partitioned areas raises the whole question of the acceptability of open plan offices. Two points arise: firstly, how strong are the feelings involved, and secondly, are there any objective consequences for the employer or individual arising from the different sizes of working area?[22] Many studies of group and industrial psychology have demonstrated the subjective importance of group membership and the feeling of belonging. There are also important consequences to a person's satisfaction in his work and his efficiency in the way that he conceives his relationships with his section, department and company; it may be that these are affected by the size of the working area or group.

Small office units hold the possibility of highly stable work groups: cohesive forces deriving from each separate group's common aims and objectives, its supervision and leadership, and the physical proximity of the members. The physical closeness of the group will be influenced not only by the absolute distances between working spaces, but also by the use of a common entrance, and the usual interactions on non-business topics when staff are circulating around such foci as the document stores, postal trays and telephones. But both special possibilities and special restrictions for group organization result from the small office arrangement.

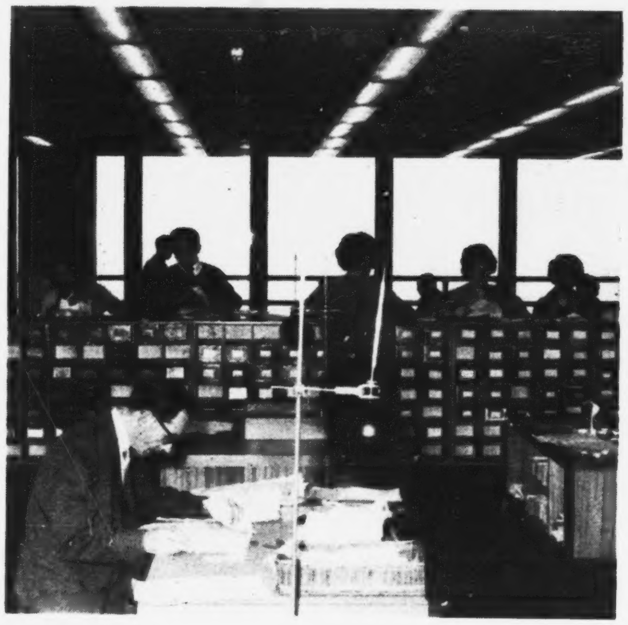

Figure 33
Members of different working groups meeting in an open-plan office.

The possibilities are of a stable group with a clear concept of itself as a discrete and simple entity. This may be good or bad, but it effectively restricts the forms of group structure that are possible because the staff occupying small areas are kept from interaction with members of the larger working unit by the walls which divide them.

By contrast, open-planning increases opportunities of inter-personal contact between members of the smaller work groupings. It is possible that there would be no change in personal relationships or group structure as a result but this seems unlikely. Open planning inevitably results in members of different sections coming into frequent contact with one another as a result of sharing entrances and services and the necessity of passing through, between or around the periphery of other groups. In addition, in open-plan offices, fewer workers will be seated beside partition walls and so more people will have greater opportunities of contact with others than they would have in smaller units.

It follows that, if the physical proximity of individuals has an important influence on the formation of inter-personal relationships and thus of friendship groups, in situations where several groups occupy one space there may occur conflicts of loyalties and identification towards and with a particular group, because some members of each section will be in very close proximity to members of one or more of the other sections.

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[21] **Anon:** Speech communication and the shape of rooms. Architects' Journal, 1957 (September 12)

[22] See appendix 5.1 for a full report upon an experimental investigation of this topic, completed since this report was drafted

It might be found that, in the absence of partition walls, sheer physical proximity becomes a potent force in determining who a person sees as the close colleagues with whom he identifies himself. If this should prove to be so, then the effect could be a considerable weakening of the structural groupings which managements are often at great pains to promote. But, whether any different behavioural or attitudinal consequences follow from closed or open office planning, and whether these are good or bad for the company and the individual, are questions that can only be answered by empirical research.[23]

Perhaps the most celebrated attempt to apply the methods of social psychology to considerations of the effect of building design on the individual was a study of the effects of spatial arrangements on group formation in various types of housing.[24] This concluded that '. . . the relationships between ecological and sociometric structures is so very marked that there can be little doubt that in these communities passive contacts are a major determinant of friendship and group formation'. It may be assumed that the spatial setting of the clerical worker has important psychological consequences. Indeed, one of the main conclusions of a study[25] of government typing pool staffs was that there were '. . . significant variations between the degree of satisfaction in different pools. Part, but not all, of the variation could be accounted for by the different sizes of the pools'. This illustration is drawn from only one of the many studies which show the influence of group size on behaviour, production or satisfaction; it has been singled out because of its concern with the typing pool which is usually regarded as one of the clerical functions most easily dealt with in a programme of rationalisation and concentration into larger working areas.

When asked to express their preference for size of office[26] typists in one of the offices studied by the Unit responded in a similar way to the rest of the clerical employees, ie, with a preference for the smaller spaces. Machine operators, on the other hand, made significantly more choices for a large open area. Two possible explanations suggest themselves: in the first place, the typists had only recently been placed in very large pools, whereas the machine operators were accustomed to the larger areas, ie, they were expressing a preference for what they knew best. An alternative explanation is in terms of actual differences between the two groups: it may be that typists and machine operators self-select themselves for their occupations on different criteria. The typists were largely composed of audio-typists, with smaller numbers of copy and stencil typists; the machine operator group was mainly composed of punch operators and smaller numbers attending the tabulators and ancillary equipment. Although the demands of the jobs may be somewhat similar, typists tend nevertheless to be regarded as having a proper clerical occupation, whereas machine operation is viewed as a quasi-industrial occupation. Consequently it would not be surprising to find fundamental differences in the attitudes, preferences and expectations of the two groups. This, indeed, was found when an analysis of replies to a questionnaire on environmental conditions showed that the machine operators differed from other female grades in over 60 percent of all cases, clearly marking themselves off as a separate sub-group.[27] Typists formed the next most homogeneous group of all the women staff, though differing in only one third of cases.

These considerations underline the need to specify the groups to which a particular piece of research is applicable. Research based on one sub-group has often been treated as though its results were applicable to all clerical groups, but the investigation referred to above showed unequivocally that such personal variables as age, sex, status, and the type of accommodation from which the respondent had earlier come, may be more influential determinants of subjective response to office conditions than the physical environmental variables themselves, at least within the range of physical variation found in the building which formed the basis of that investigation.[28]

Spatial considerations in the design of office buildings

The shape of office space

A particular site may impose limitations upon a designer's freedom to shape his offices. Otherwise, the shape of individual office spaces is most likely to be determined by daylighting policy or a requirement for the use of private offices.

Where full daylighting from side windows is required, then this consideration is the most important determinant. General offices (say for 20 people or more) will tend to be long and narrow; the depth from window wall will rarely exceed 15 ft. Similarly if a large number of private offices are required, then the depth of the private offices (which may be a maximum of 12 to 15 ft) will tend also to be the depth of general offices.

Where an office building is built for letting, the optimum size of space for individual tenancies will determine the planning unit. If tenancies are expected to be small, the tendency will be for the depth of *all* office space to be determined by the maximum acceptable depth for single rooms, say, not more than 15 ft and the width (or length) of any particular office room will consist of an additive series of private room widths. If tenancies are expected to be large, then whole floors of office buildings might be designed to be the plan unit in the expectation that they will be used as open-plan offices.

The number and size of floors in an office building

The distribution of the total net floor area of a building upon several floors is most likely to depend upon one or more of the following:

(i) the site, and any restrictions (such as floor index ratio) it may impose. In some locations planning restrictions may limit the height to conform with adjacent or surrounding buildings. Elsewhere, a greater height may be required to be provided than a developer would wish

(ii) policy decisions, eg, about daylighting (a demand for daylight limits building width and therefore, given a maximum length, the area per floor) or the prestige or advertising value of, say, high buildings

(iii) (in respect of buildings to be tenanted) assumptions about the optimum size of offices for letting

(iv) (in respect of buildings to be occupied by their owners) decisions about the actual size of departments or working groups

(v) economic considerations. For example, increasing height results in increasing cost and a decreasing usable (or lettable) proportion of the total area.

The office location study[29] showed that the number of storeys in typical post-war office buildings ranged from three to twelve.

The form of office buildings

There are two basic plan-types, which derive from the method of providing access and services: (i) the slab-type block, which has an access corridor in the middle

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23. This research was continuing during the period in which this report was being edited and published. See appendix 5.1
24. **Festinger, L., Schachter, S.** and **Back, K**: Social pressures in informal groups. Tavistock Publications, 1959 (First published in USA in 1950) 2nd edition 1963: Stanford, Calif: Stanford UP
25. **Anstey, E., Baines, A. H. J.** and **Stansfield, R. G**: Work preferences of typing pool staff in the Board of Trade. Unpublished paper, quoted in: **Walker, Nigel**: Morale in the Civil Service: a study of the desk worker. Edinburgh University Press 1961
26. See chapter 10
27. See chapter 10
28. See chapter 10
29. See chapter 3

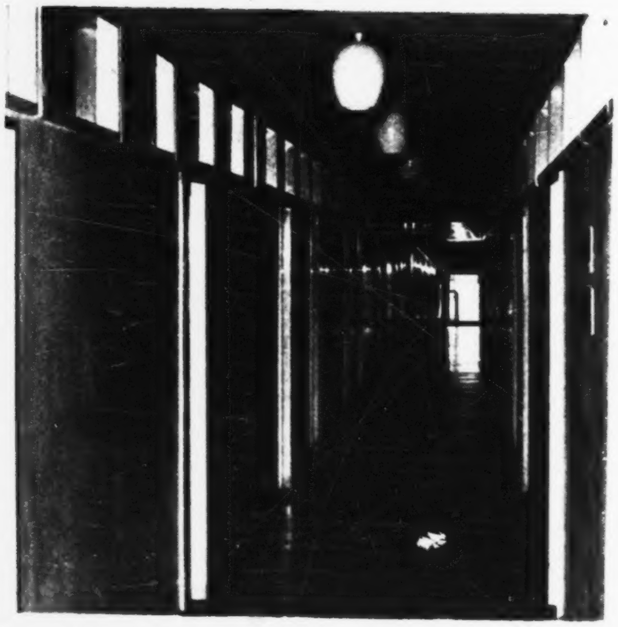

Figure 34
Central corridor in a slab-type plan.

and offices on either side, and (ii) the core-type plan, where lifts, stairs, ducts, lavatories, etc. form a central core which is surrounded by a circulation area which in turn is surrounded by office space. The horizontal and vertical circulation systems affect both the economic and functional efficiency of the building. If the building is expected to be tenanted, then the slab type plan may be inevitable, for the need will be for small units of relatively shallow space which can be let off as units. Because of its duplicated circulation, a core-type plan would tend to be economic for letting only if large tenancies (ie, whole floors, or deep offices) were anticipated.

To obtain the most efficient and economic distribution of office space, simple slab or block plan shapes are preferred. Intersecting blocks such as cross and double-cross plan-forms create overshadowing and (possibly) unacceptable areas in the 'dead space' at the point of intersection.

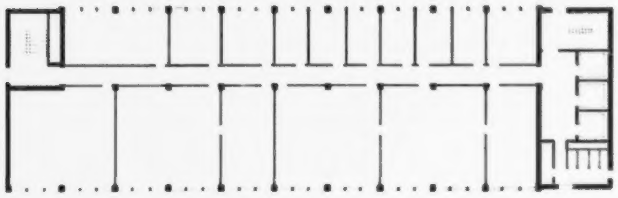

Figure 35
Slab-type plan.

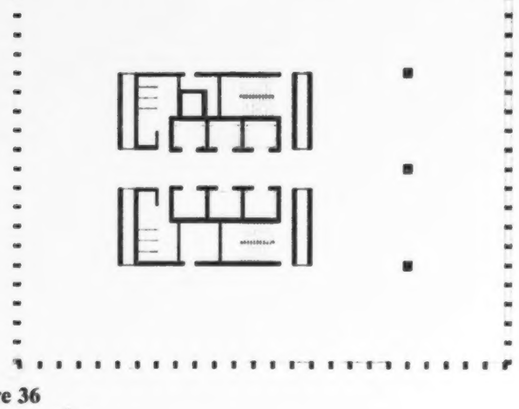

Figure 36
Core-type plan.

Plan ratios

The usable proportion of a building's total area is most dependent on its 'class'. For example, a high ratio of net (or lettable) space[30] to gross space[31] of (say) 80 percent would be appropriate to a strictly functional building, whereas a ratio appropriate to a prestige building might be two-thirds[32] or less.

Planning dimensions and modules

The dimensioning of office buildings, as with many other building types, is now commonly carried out to unit dimensions, or 'modules'. These ensure a unit size for offices by providing a regular grid for the positioning of partitions. Windows and heaters, light fittings and other fittings have to be positioned in a regular pattern. The most general use of modules is along the length of the external wall and this will be related to such structural dimensions as the lateral spacing of stanchions. The adoption of a particular module may depend upon (i) whether offices are mainly private, or (ii) whether offices are mainly open-plan. For office planning purposes modules are likely to be important only when (a) some private offices will be needed and (b) in open-plan offices when the external wall is a solid pierced by windows, with substantial areas of wall between the windows. Otherwise, modules are likely to be used mainly for their constructional convenience.

Figure 37
Office building designed to allow sub-division of open floors into smaller spaces. Size of individual single-window rooms can be varied within limits of lines on walls between windows.

If planning is based on an expectation of private offices, then the minimum dimension of a single room (along the window wall, usually) will be the determining factor. This is likely to be of the order of 8 ft[33, 34, 35] and, because they will often be related to window units as well, modules of between 4 ft and 4 ft 6 ins are common. Where there are wide areas of wall between windows there is scope for considerable variability in the size of individual rooms.

Alternative (square) modules of 3 ft 8 ins, 4 ft or 4 ft 4 ins (giving 'small', 'standard' and 'commodious' space alternatives) have been recommended, and examples given of individual rooms and open-plan offices planned on these bases.[36, 37] A wide variety of modules has been used for office buildings, varying from about 2 or 3 ft[38] up to 20 ft but there is a large measure of aggregation around 4 ft 3 ins or 4 ft 6 ins up to about 7 ft.[39]

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[30] Besides offices, this includes canteens, conference rooms, archives, and all other ancillaries which actively assist the main work of the firm

[31] Strictly, net floor area to gross floor area

[32] **Manasseh, Leonard** and **Cunliffe, Roger**: **Office Buildings.** Batsford, 1962

[33] **Manasseh, L.** and **Cunliffe, R**: op cit (32)

[34] **Fischer, Manfred**: Von den Planungsgrundlagen bis zur Arbeitsplatzanordnung. Das Rationalle Büro, 1962 (5)

[35] **Marr, A. N**: (contribution to discussion): **Office Buildings**: report of a symposium held on 12th April 1956 at the Royal Institute of British Architects. (The Institute), 1956

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36. **Cowgill, Clinton H:** Executive architecture. J Amer Inst Archt. 1959 (April)
37. **Cowgill, Clinton H:** Planning the law office. American Bar Association: Economics of law practice series, pamphlet no. 4 (The Association), 1959
38. **Ministry of Public Building and Works:** Dimensional coordination for Crown office buildings. HMSO, 1964
39. **Holford, Sir William:** (contribution to discussion): Office buildings: report of a symposium held on 12th April 1956 at the Royal Institute of British Architects. (The Institute), 1956

Chapter 6
The visual environment

Previous surveys of the visual environment in offices

Of all the components of the total environment within offices, the one which has perhaps received most attention is lighting. Even so, a study group, reporting in 1947 on the work it had done during the war, concluded that the most urgently needed reform in Civil Service working conditions was improved lighting.[1] It held that a first essential in the design of an office building is the provision of good natural lighting, and suggested that the depth of rooms should not exceed 1¾ times the height (where windows occur on only one side) or four times the height (where windows occur on two opposite sides). It was reported that the area of windows in immediately pre-war commercial offices usually exceeded one-third of the total external wall area. Standards of lighting were suggested which would provide visual conditions considerably better than those which were current, including values of illumination on desks of 10 lm./sq.ft (with a minimum of 8 lm./sq.ft) for clerical work, and general systems of lighting to avoid the possibility of glare from desk lamps. Light matt colours were considered advisable; cream ceilings and light buff walls were recommended. More tentative suggestions were made for consideration of the colour of office furniture.

The office lighting survey[2] conducted by the Central Office of Information provided a great deal of information about this topic. Its more important findings were that in 1948 7 percent of office staff worked in rooms without windows (though most of these had glass partitions or rooflights) and 15 percent in rooms having areas of window glazing below the then current bye-law minimum of one-tenth the floor area. 21 percent of staff received no direct daylight on their work. The average value of all measurements of illumination from daylight and electric light combined was 15.4 lm./sq.ft but the most frequently observed value was only 8 lm./sq.ft. There was apparently slightly more satisfaction with electric light than daylight, but the report remarked on the probability that electric lighting was assessed against lower standards of satisfaction. Criticism of electric light tended to be of quality rather than quantity.

Wattleworth reported[3] that lighting conditions in Liverpool, as measured during 1955 and 1958 showed people working in inadequate daylight or in windowless rooms. Illumination levels from electric lighting were below 20 lm./sq.ft on the majority of desks in 660 out of 913 suites of offices.[4] In 27 percent of offices artificial light was needed during most of the day.

In Barrow,[5] illumination levels in 11 out of 50 offices were below 10 lm./sq.ft and in 34 percent below 20 lm./sq.ft even when daylight and electric light were used together. In half the offices the light fittings, and in one-seventh the windows, were visibly dirty.

Light was measured at both the best and worst naturally lighted working points in each room visited in the City of London.[6] The illumination at both positions was measured in two stages – first from daylight and then from daylight plus full electric lighting. At the time measurements were made, 37 percent of the best and 75 percent of the worst work stations received less than 30 lm./sq.ft from daylight alone. At least 90 percent of all measurements of illumination from electric lighting were below the IES standard[7] of 30 lm./sq.ft which is now current. 1,347 observations of glare suggested to the one observer that in City of London offices this was not as acute a problem as bad illumination.

'The most satisfactory feature' of the eight mechanised offices[8] was the quality of daylighting, although the criterion of satisfaction was not, apparently, the ability to work by daylight alone. Daylight factors calculated in the worst positions varied from 20 percent down to 1.5 percent. However, in view of the practical difficulties of calculating daylight factors, these values must be treated with some reserve. Illumination from electric lighting ranged from 9 to 29 lm./sq.ft but the staff everywhere were 'reasonably well satisfied'; the chief source of dissatisfaction appeared to be variations in intensity and quality in different parts of working areas.

The most recent publication of the Building Research Station's work on office environment[9] has summarised the results of a series of studies (most of which still await publication), stating that, in modern offices, less than a third of the working time in winter and no more than a half in summer, can be spent without supplementary lighting. In south-facing offices in London whose external walls are completely glazed, 17 percent of the staff found the daylight inadequate while, *at the same time*, 24 percent, working near the windows, found conditions too bright. Electric lighting was found to be 'one of the most satisfactory features of the present day office', even though only a minority of installations reach the levels recommended in the 1961 IES Code.[10]

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[1] **Study Group appointed by HM Treasury:** Working conditions in the Civil Service. HMSO, 1947

[2] **Gray, P. G. and Corlett, T:** A survey of lighting in offices. Appendix to Post-war building studies no. 30. HMSO, 1952

[3] **Wattleworth, W. H:** The forgotten army. Royal Society of Health Journal, 1959 (March-April)

[4] **Wattleworth, W. H:** Unfinished business in environmental health. Royal Society of Health Journal, 1958 (May-June)

[5] **Nelson, I. D. M. and Morse, R. J:** A pilot study of office accommodation. The Medical Officer, 1960 (September 9)

[6] **Robinson, Alan:** Working in the city: the interim report of a survey. City of London Health Department, 1962 (December)

[7] **Illuminating Engineering Society:** The IES Code: Recommendations for good interior lighting. (The Society), 1961

[8] **Langdon, F. J:** The design of mechanised offices. Architects' Journal, 1963 (May 1 and 22)

[9] **Langdon, F. J. and Keighley, E. C:** User research in office design. Architects' Journal, 1964 (February 5)

Legislation

The requirements of the new office legislation[11] are expressed in only general terms which few existing offices could not claim to meet: 'Effective provision shall be made for securing and maintaining, in every part of the premises . . . in which persons are working or passing, sufficient and suitable lighting, whether natural or artificial'. The Minister may prescribe standards by regulations but none have yet been made. So far as is reasonably practicable windows and skylights must be kept clean and unobstructed; whitewashing or shading to mitigate glare or heat gains is permitted; electric lighting apparatus has to be properly maintained.

Requirements of the visual environment

The requirements of the visual environment for office work are:

- (i) good lighting and, possibly,
- (ii) a view, and
- (iii) good colour.

Good lighting

Good lighting in offices has two aspects: (a) functional – ie, the service of the work and (b) aesthetic – the creation of a pleasing and appropriate character. Both are qualitative, but whereas the first is now largely definable in quantitative terms, the second still remains the province of emotion and artistry (or design judgement). The two aspects are more than complementary for it is possible that 'function' may constitute a significant proportion of the aesthetic content, and vice versa.

In Britain the authoritative guide to lighting is the IES Code.[12] This publication states the three chief aims of good lighting as the promotion of work (or other activities), the promotion of safety and the creation, in conjunction with the structure and decoration, of a pleasing environment conducive to interest and a sense of well-being. The realisation of these aims involves:

> '(a) careful planning of the brightness and colour patterns within both the working area and the surroundings so that attention is drawn naturally to the important areas, detail is seen quickly and accurately and the room is free from any sense of gloom or monotony;
>
> (b) using directional lighting where appropriate to assist perception of task detail and to give good modelling;
>
> (c) controlling direct and reflected glare from light sources to eliminate visual discomfort;
>
> (d) in artificial lighting installations, minimising flicker from certain types of lamp and paying attention to the colour rendering properties of the light;
>
> (e) correlating lighting throughout the building to prevent excessive differences between adjacent areas and so to reduce the risk of accidents;
>
> (f) installing emergency lighting systems where necessary'.[13]

Since this present report is primarily concerned with the design of the workplace environment (and little concerned with the functioning of the building as a whole) items (e) and (f) above will not be considered further.

Brightness patterns

The pattern of brightness in a workplace has three main parts – the visual task, the immediate background to that task and the general surroundings. The size of critical detail[14] determines an appropriate value of brightness of the task for an acceptable high level of visual performance[15] and this is expressed in terms of the required illumination[16] on the task. These are the methods developed in Britain. In the U.S.A. methods based on analyses of the process of vision have formed the basis of the very different recommendations of the American IES.[17]

When the brightness of the task has been set, the brightness of the other parts of the environment are determined. The general rule is that the task should be brighter than its background which in turn should be brighter than the general surroundings.

The British IES Code suggests[18] a relationship between the brightnesses of task, background and surroundings appropriate to office lighting of the order of 10:3:1 but adds that because of the limited data available this should be regarded as general guidance only. The ratio of minimum to maximum illumination over the working area of a space should not be less than 0.7.[19]

Standards of illumination

The IES Code specifies a normal minimum illumination for the interiors of buildings of 15 lm./sq.ft. Recommended standards for working areas of offices are:

General offices	30 lm./sq.ft[20]
Business machine operation	45 lm./sq.ft
Conference rooms and executive offices	30 lm./sq.ft
Entrance halls and reception areas	15 lm./sq.ft

Recommended illumination levels, in Britain and in other countries, are ultimately based on judgement and are compromises between higher levels of illumination required for higher standards of visual accuracy and the economic consequences of very high illumination levels. Standards differ between countries (table 4).

Table 4

Comparisons of recommended illumination values for general offices in different countries. lm./sq.ft (approx)

France 1961	minimum	30
	recommended	60
Germany (draft 1962)		12 to 25
Britain 1961		30
Sweden 1962		30 to 100
U.S.A. 1959		100 to 150
U.S.S.R. 1959		fluorescent 20 to 30
		incandescent 7.5 to 15*

Source: **Commission Internationale de L'Eclairage:** Report of Committee S-4.2: Lighting codes, regulations and legislation. Proceedings, Vienna, 1963. Volume C. Paris (The Commission), 1964.

*Why the U.S.S.R. should recommend different values for different light sources is not clear, it is presumably due either to greater practical difficulties of achieving higher standards with incandescent lamps or to the higher running costs of such an installation.

While legal minimum standards of illumination will tend to be exceeded by a majority of lighting users[21] the recommended illumination values of the IES Code are at present in advance of general practice. This is apparent from the standards of the Ministry of Public Building and Works[22] for government offices (table 5) and most of the offices visited during this project. In only one of the six offices in which levels of illumination from electric lighting installations were measured was the present IES standard exceeded. The other buildings are probably representative of average or better-than-average conditions, yet they all fell below the IES standard. Several of the buildings were substantially overshadowed; for this and other reasons it was rarely possible to take measurements of daylight factor.[23]

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[10] Mr. J. A. Lynes has pointed out that the only obvious conclusion to emerge from this summary of previous surveys is that where lighting has been measured against a physical criterion, such as the IES Code recommended illumination values, it has invariably been found inadequate. Where it has been assessed subjectively, it has always been found fairly satisfactory

[11] Offices, Shops and Railway Premises Act, 1963. HMSO

[12] **Illuminating Engineering Society:** op cit (7)

[13] **Illuminating Engineering Society:** op cit (7)

[14] ie, the angular size of the smallest detail which has to be seen, measured in minutes of arc subtended at the eye

[15] In the IES Code this is taken to be within a range of between (approximately) 90 and 100 percent 'of the maximum performance of any visual task which ideal conditions could yield'

[16] By reference to the task's reflection characteristics

[17] **Illuminating Engineering Society** (of the USA): IES lighting handbook. (The Society) 3rd edition. New York, 1959

[18] **Illuminating Engineering Society:** op cit (7)

[19] **Illuminating Engineering Society:** op cit (7)

[20] Compare with the 'average minimum value of daylight illumination tolerable for clerical work' of about 5 lm./sq.ft reported in **Illumination Research Committee:** Daylight illumination necessary for clerical work. Illumination research technical paper no. 19. HMSO, 1937

[21] No regulations determining standards of illumination for office premises have been made yet (November 1964). In factories the generally applicable legal minimum level of illumination (6 lm./sq.ft) is almost always exceeded in practice

Table 5
Standards of illumination for government offices.
lm./sq.ft

Location or type of task	Standards introduced in 1960 (not yet universal)	Standards applicable before 1960 (may still exist in buildings completed before 1960)
General office work	23-15*	10-6*
Book-keeping, typing and work involving sustained reading	23-15	15-10

Source: **Society of Civil Servants:** Office accommodation and allied subjects. 1963.
*First figure represents approximate average illumination when lamps, fittings and decorations are new and clean.

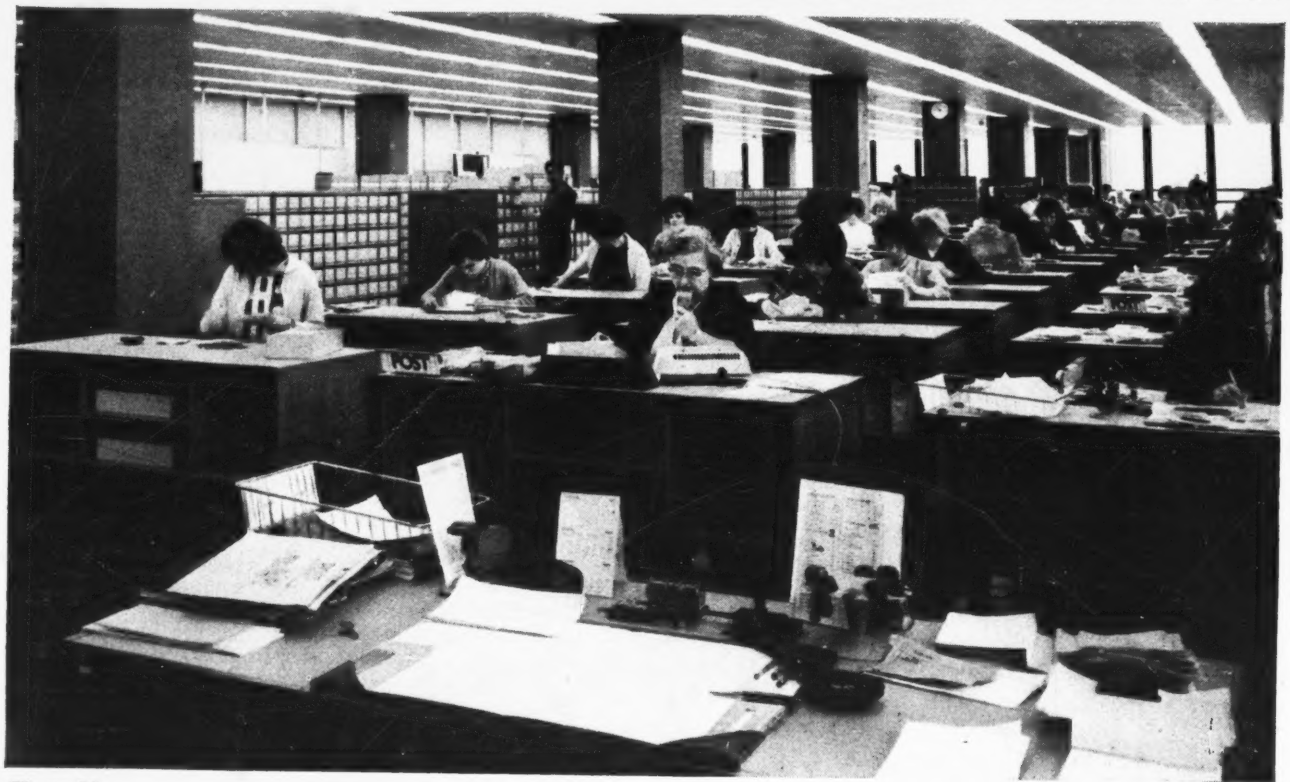

Figure 38
Most clerical tasks are on horizontal surfaces.

Directional characteristics of lighting

In office buildings illuminated largely by daylight through side windows, lighting will tend to be mainly directional and have pronounced modelling characteristics. Electric light fittings will be mounted overhead, at frequent intervals; from such an installation the illumination received at a point on the working plane will tend to be omni-directional and shadowless. Measurements of illumination are commonly made on the horizontal plane but many office functions (eg, filing) require the working illumination to be on *vertical* surfaces and this may be more difficult to provide by electric lighting.

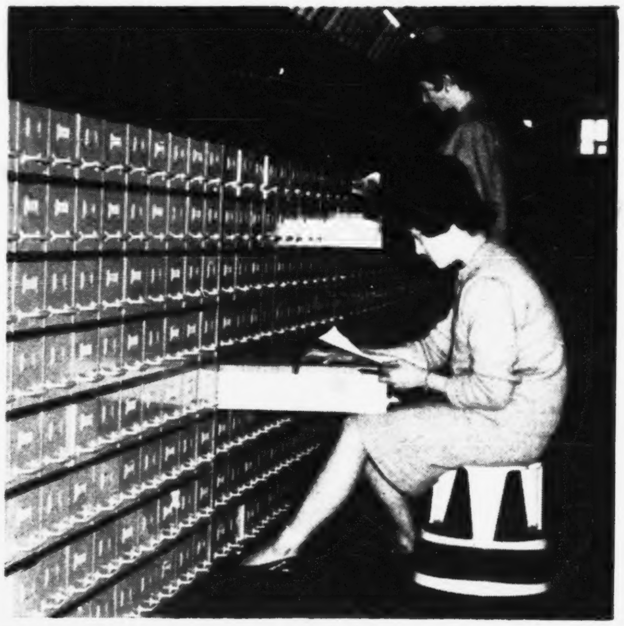

Figure 39
Light needed on vertical plane.

Control of glare

Glare is defined as 'a condition of vision in which there is discomfort or a reduction in the ability to see significant objects, or both, due to an unsuitable distribution or range of brightness or to extreme contrasts, simultaneous or successive, in the field of view'.[24] Popular usage of the term may not imply the same experience as the one defined. Glare is not always immediately or readily apparent and people may complain of glare only when the condition is extreme. It may be direct, as from a light fitting or window, or reflected, as from the polished surface of a desk.

Factors influencing direct glare include the brightness and area of the light sources, their position and the average brightness of the room background. Tolerance limits, 'based on good current practice', of Glare Index applicable to the office (not the task) are recommended in the IES Code; no comparable standards exist in other countries although it is believed that the matter is under active consideration in several European countries.

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[22] See: **Society of Civil Servants:** Office accommodation and allied subjects. (The Society), 1963 (January)
[23] This point is discussed later in this chapter
[24] **Illuminating Engineering Society:** op cit (7)

Reflected glare has to be controlled by the positioning of light fittings and use of a matt finish for potential reflecting surfaces.

Control of flicker

Stroboscopic and flicker effects from fluorescent fittings can be largely eliminated by suitable installation and circuitry.[25,26]

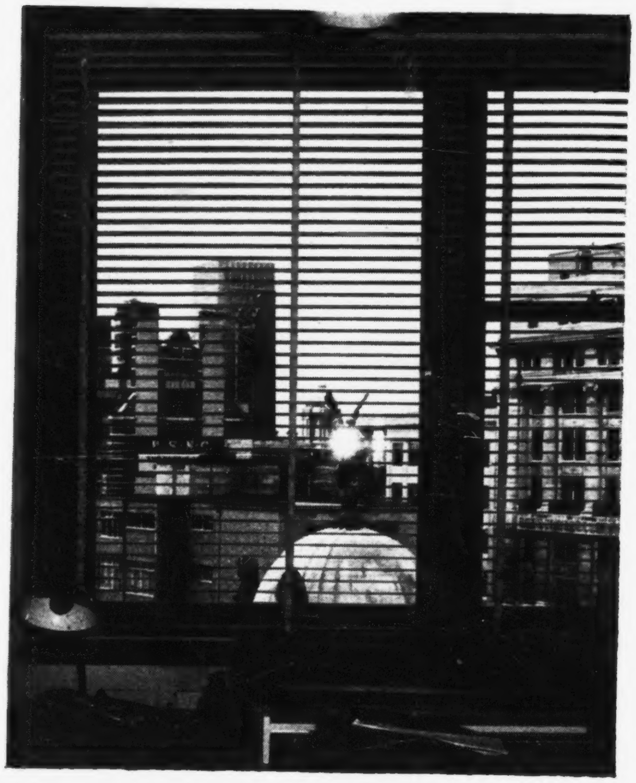

Figure 40
A 'visual rest centre' and a view of the outside world.

A view

Most types of office work are said to create a need for a 'visual rest centre', where the eyes have an opportunity to refocus upon a more distant scene. According to the Building Research Station,[27] 'Not much is known of the factors which determine what is a good visual rest centre, except that it should under no circumstances be bright in relation to the work'. Yet the most popular form of visual rest centre is undoubtedly a window with a view. Nearly 90 percent of the 2,500 respondents to the first CIS questionnaire[28] considered that it was important to be able to see out of the office, and though the psychological need for a link with the outside world (with a realisation of the time of day and state of weather) is generally appreciated, the actual nature of the need is little understood. A point which may not be generally recognised is that provided a window is located at eye level and is large enough, a view through can be obtained from deep (ie, at least 60 to 70 ft) within a room. In the allocation of window space practice varies between different organisations. It is reported that in some firms in the U.S.A. the higher executives are accommodated in air-conditioned inner rooms without windows so that space with natural daylight is available for staff performing clerical work or machine operations.[29] It is probably much more general, though, for executives to be located on the perimeter, and lower-rank staff to be seated in the interior.

Colour

The colours employed within an office in the form of decorations applied to wall and ceiling surfaces and the finish of floors, furniture, fittings, etc, have a complex effect upon an environment. This effect is both physical (eg, colours with a high Munsell value[30] will reflect more light and therefore contribute to the general illumination), and subjective (colours contributing to the character and 'mood' of a space).

The colour rendering characteristics of an environment depend upon the type of light and the colour and reflection characteristics of the surfaces. Daylight containing direct sunlight will give a rendering of a colour different from sun-less north light; various types of electric lamp have varying colour rendering properties.[31] The IES Code suggests that, where colour discrimination is critical, illumination levels should be high and not less than 45 lm./sq.ft.[32]

In the offices in which illumination surveys were made, the usefulness of high reflective colours for the ceilings had been recognised, but values for walls were found to be much lower and for floors, variable.[33] In the one building where the office staff's opinion about their colour schemes was sought the general attitude was critical.[34] This was surprising for of all the offices which have been visited this has the most highly developed pattern of decorations. It is subdued yet sophisticated and reasonably well integrated through all the room surfaces, furnishings and fittings, yet the staff chose the words 'cold', 'mediocre' and 'dull' to describe it. It seems that the criticisms were, in fact, of the very sophistication of the 'colour design,' and its tendency to cool colours.[35] Langdon found similar results in his studies of mechanised offices: 'almost all the colour treatments were rated too cold'.[36]

Aesthetic effects of lighting

It is not possible at this stage to say anything about qualitative aspects of office lighting over and above those affecting its functional performance. Whilst most people believe that such higher aesthetic values exist, it has yet to be proved that they do. Certainly, no visual environments experienced during the course of this study offer any suggestion that lighting in offices can be better than utilitarian.

Source of illumination

Due to two factors, (i) the congestion and consequent overshadowing of central areas and (ii) the high levels of illumination now considered necessary, daylight in offices is increasingly coming to be regarded as, essentially, an amenity, while electric lighting is used to provide the working illumination. This, at least, is the direction of informed opinion in Britain and the IES Code[37] has been expressly framed in these terms. Experience during this study suggests that for most offices in city centres this approach has to be accepted as the only realistic one. The Building Research Station has developed the concept of PSALI in which electric lighting is used to brighten up apparently darker areas and provide the working illumination in positions distant from windows 'without destroying the essential character and direction

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25. **Collins, J. B.** and **Hopkinson, R. G:** Flicker discomfort in relation to the lighting of buildings. Trans Illum Eng Soc.(London). 1954 **19,** (5) 135-158
26. **Illuminating Engineering Society:** op cit (7)
27. **Building Research Station:** Some general principles of the lighting of buildings. BRS digest no. 70. HMSO, 1954 (October)
28. Discussed in chapter 10
29. **Milward, G. E.** (Ed): Organisation and methods. Macmillan. Revised edition, 1962
30. Value is one of the ordinates in the Munsell system and is a measure of the lightness or darkness of a colour. It ranges from 0 (black) through the darker and then lighter colours to 10 (white)
31. See table 1 in: **Gloag, H. L:** Colouring in factories. Factory building studies no. 8. HMSO, 1961
32. **Illuminating Engineering Society:** op cit (7)
33. For report upon these surveys, see later in this chapter and appendix 6.2
34. See chapter 10
35. **Manning, Peter** and **Wells, Brian:** CIS: re-appraisal of an environment. Interior Design, 1964 (May/June)
36. **Langdon, F. J:** op cit (8)
37. ie, the latest (1961) edition

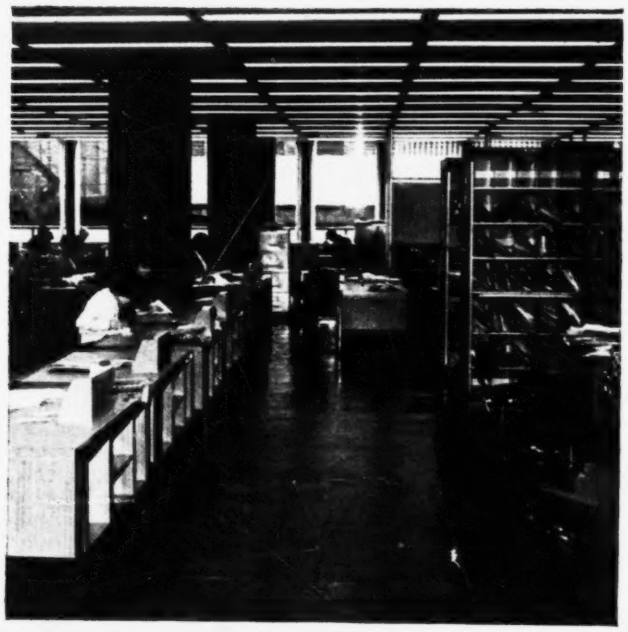

Figure 41
Working illumination provided by electric light in deep office space.

of the dominant daylighting'.[38] Its authors describe it as suitable for rooms (with windows on one side) of 20 to 40ft depth; it does not seem to be appropriate for the deep spaces which are a current tendency in office design.[39] So far, there are few office lighting schemes in existence which have been designed to the BRS PSALI method and it is not clear whether in ultimate effect the results differ significantly from well-designed straightforward electric lighting systems.

It can be expected that office workers will prefer a daylit environment to one illuminated by electric lighting, usually on the score that it is better for the workers' eyes to work in daylight. This point has not been proved[40] but nevertheless it is held – for example, by over two-thirds of the staff of the CIS,[41] and, judging by the designs of some recent Crown buildings, this is probably an important consideration in the design of new office buildings for the Civil Service.[42] An interesting finding of this present study[43] has been that people may not be able to distinguish between the different types of light: staff working up to about 75 feet from a window in a deep office building which is continuously illuminated by electric light greatly over-estimated the proportion of daylight in their total working illumination. It is possible that the general preference for daylight is based upon an expectation and experience of crude lighting installations. Bickerdike, referring to the user-opinions reported in the COI survey of office lighting[44] suggested that reactions to the use of supplementary electric lighting were prejudiced by known conditions which were not comparable with the kind of environments possible today.[45]

Daylight

The recommendations of the IES Code are based on the assumption that for most buildings, especially those in built-up city centres, it will be necessary to supplement daylight by electric light used constantly during the day. Values of daylight factor recommended are 'minimum requirements . . . for amenity and function . . .' For offices, this value is 1 percent.[46] Higher values are recommended in the appropriate Code of Practice[47] but these can rarely be obtained without top lighting and are consequently inapplicable to the great majority of city office buildings.

Windows

Since most office buildings are multi-storey, windows can only be provided in the perimeter walls. These have several effects upon the environment. Besides being the source of daylight, they:

(i) provide views out of and into the building
(ii) create surfaces of very low reflectivity at night
(iii) are usually the principal means of ventilation and will therefore admit any atmospheric pollution which may be present in the external environment
(iv) provide a weak link in the external fabric of the building allowing heat to escape from the interior and heat gains from solar radiation to be admitted
(v) allow the passage of noise from one side of the wall to the other more readily than most 'opaque' wall constructions.

If windows are providing the working illumination, then views of bright areas of sky with attendant discomfort from glare may be inevitable. Where working illumination is provided by electricity, then the window area can be reduced and the view selected. In a high building, for example, a downward view may be preferable to an upwards or horizontal one. In deep office buildings the need will be for large areas of windows to provide the best views for people working in the interior of the building. This may make necessary some form of external sun-shading device.

The real problem of window design is the need to reconcile conflicting requirements. As a general rule, the

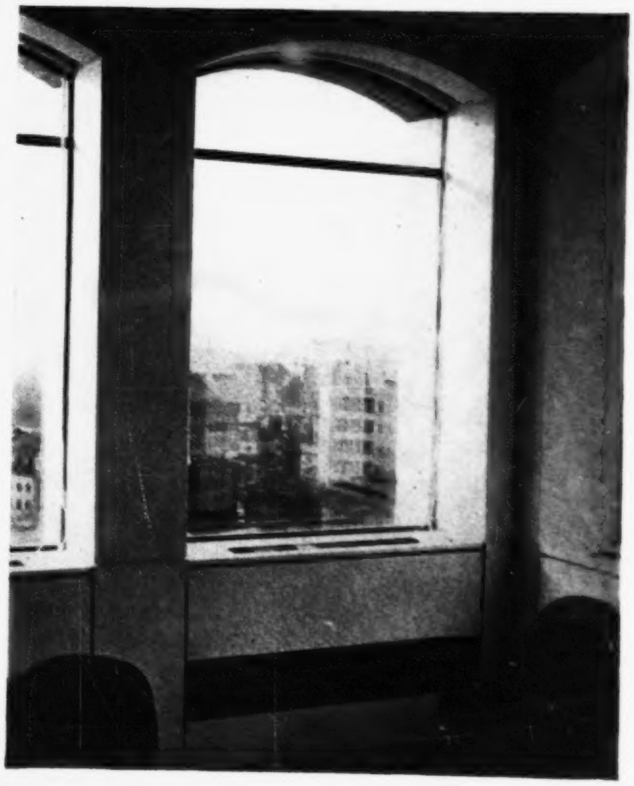

Figure 42
Window forming the basis for a modular planning unit.

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[38] **Hopkinson, R. G.** and **Longmore, J:** The use of permanent supplementary artificial lighting. Architects' Journal, 1959 (October 8)
[39] A more detailed discussion of this topic occurs later in this chapter
[40] **Weston, H. C.,** speaking at a conference organised by the British Lighting Council, said that there was no medical evidence of ocular ill-effects from the use of fluorescent lighting
[41] See chapter 10
[42] The Society of Civil Servants booklet which sets out the various agreed rules governing accommodation commences the section on Lighting by drawing attention to the Civil Service's own Study Group's declaration that the first essential of all clerical accommodation should be adequate natural lighting
[43] Reported later in this chapter
[44] **Gray, P. G.** and **Corlett, T:** op cit (2)
[45] **Bickerdike, John:** Lighting. Paper in: Office buildings: report of a symposium held on 12 April 1956 at the Royal Institute of British Architects. (The Institute), 1956
[46] **Illuminating Engineering Society:** op cit (7)
[47] **Council for Codes of Practice: British Standards Institution:** Code of basic data for the design of buildings. Chapter 1: Lighting; Part 1: Daylighting. British Standards Code of Practice C.P.3: Chapter 1: Part 1 (1964) (The Institution), 1964

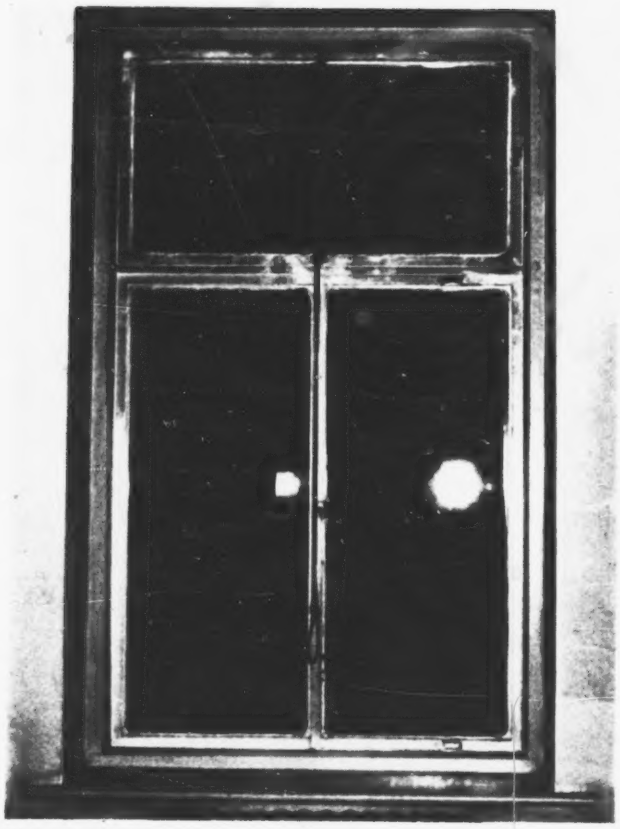

Figure 43
Windows: surfaces of very low reflectivity at night time.

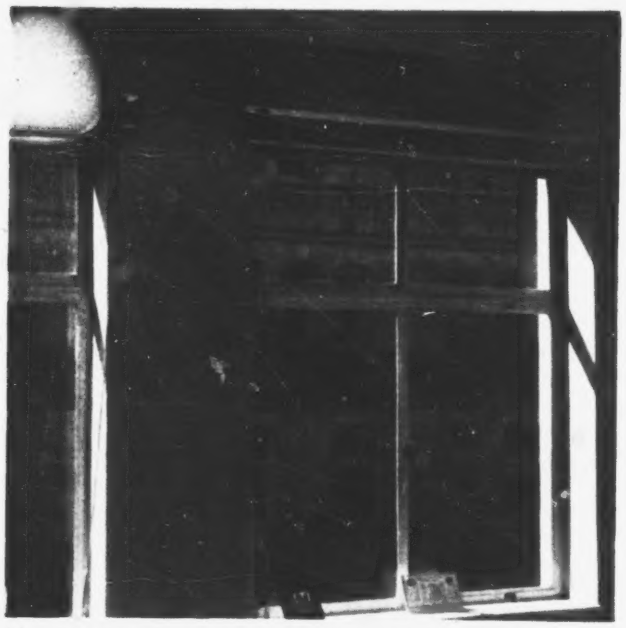

Figure 44
Obstruction of windows by nearby buildings.

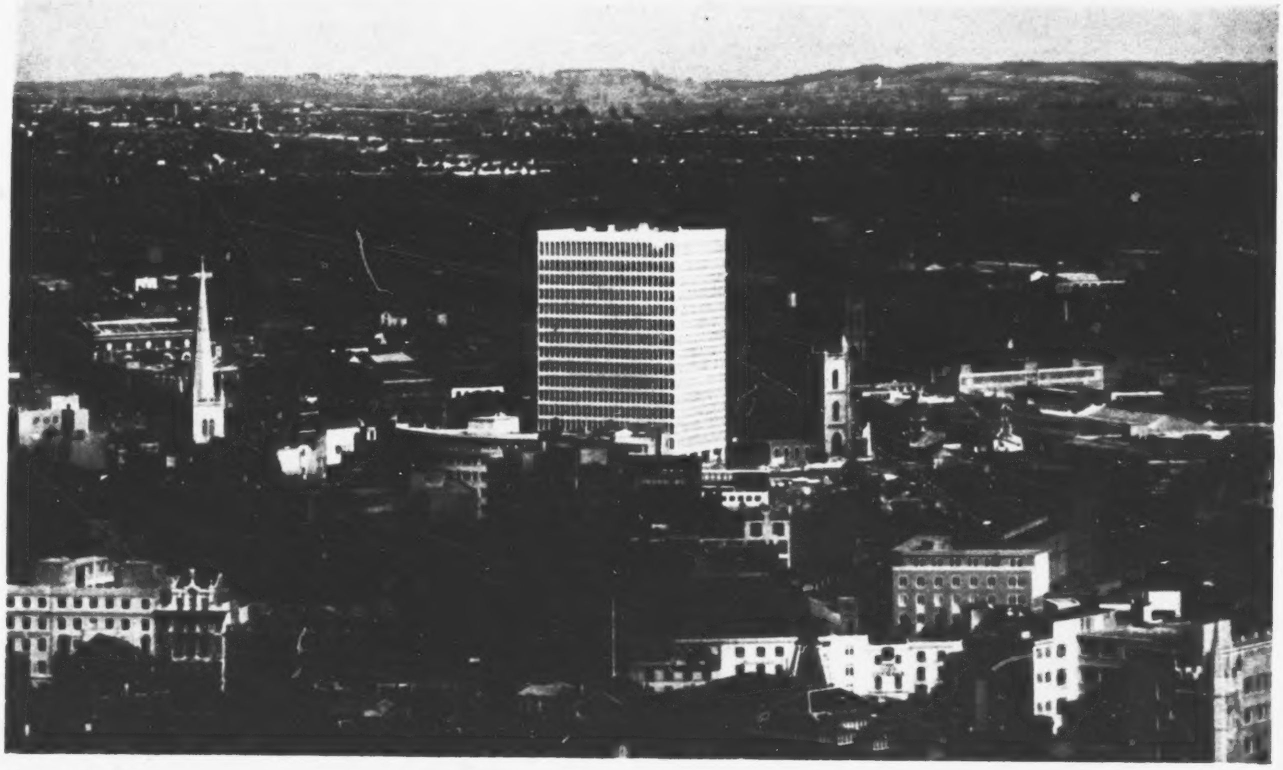

Figure 45
A tall building on a low site; practically all staff obtain an interesting view from their desks.

greatest possible amount of glass is needed for light and view while the least amount restricts heat gains and losses and the admission of street noise. Many office buildings are planned on the basis of an overriding concern with maximum admission of daylight, (eg, 'the highest possible proportion of the outside walls of a building should consist of windows . . .')[48] when, even now, with present illumination needs and the constantly rising standards which can be expected, reliance has increasingly to be placed on electric lighting.

Heat loss through windows, and condensation on window glass will be reduced by insulating (eg, double) glazing.[49] However it may not be economic to use double glazing only to reduce heat losses[50] for heat may also escape by leakage around windows. In very high buildings opening lights are almost certain to require weather stripping and it is likely that they can be opened only during the occasional day when the air is still.

In buildings which have mechanical ventilation, windows will be both cheaper and more efficient if they are fixed. 'Psychological' reasons for openable windows may be advanced[51] but it is probable that staff's initial concern is reduced with time. Openable windows may be preferred for ventilation in the events of fire or breakdown of mechanical ventilating equipment and for access to cleaning cradles.[52] Opening part – even the

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48. **Imperial Chemical Industries Limited:** Standards for offices and laboratories. (The Company), 1960

49. See, for example, **Markus, Thomas A:** Daylight with insulation. Pilkington Brothers Limited, 1960

50. See, for example, **Imperial Chemical Industries Limited:** op cit (48)

51. See, for example, **Joedicke, Jürgen:** Office buildings. Crosby Lockwood, 1962

52. **Bailey, George R., Gilbert, F. L. and Wilds, Horace W:** Commercial office buildings. Paper in: Performance of buildings. Publication no. 879 of Building Research Institute, Washington D.C. (The Institute), 1961

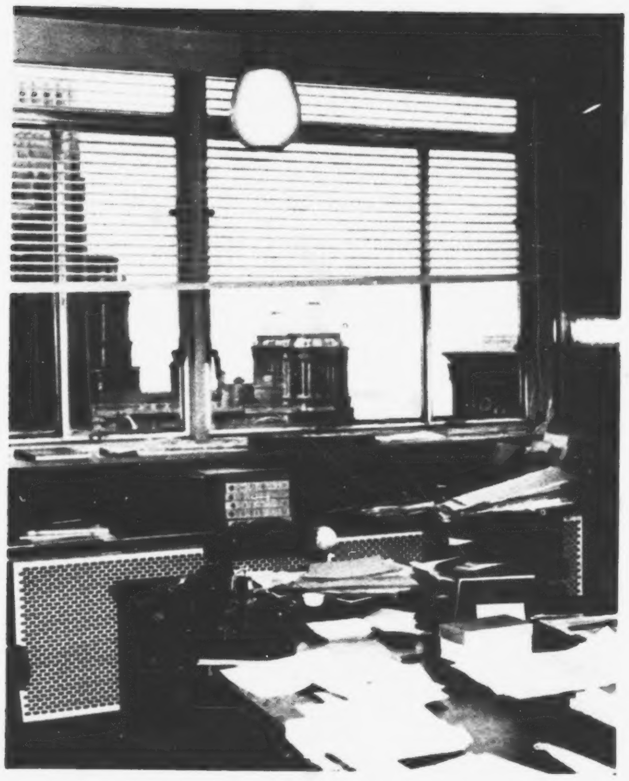

Figure 46
The problem in window design is to reconcile conflicting requirements. In this building, windows are large to obtain the maximum amount of light and take advantage of the view. Venetian blinds are provided to minimise sky glare and solar heat gains.

top – of windows for ventilation may create draughts and cause discomfort and papers may be blown off desks. Pivotted opening lights are liable to foul blinds and curtains.

In an approximately south exposure, double glazing consisting of an external skin of ¼ inch heat-absorbing glass and an internal skin of 32 oz glass may create temperature conditions in an office during periods of direct sunlight 5 to 7 deg F lower than in similar offices entirely double glazed with 32 oz sheet glass.[53] A guide to the selection of screening devices such as curtains, brise-soleil and venetian blinds is included in the *Architects' Journal* design guides.[54]

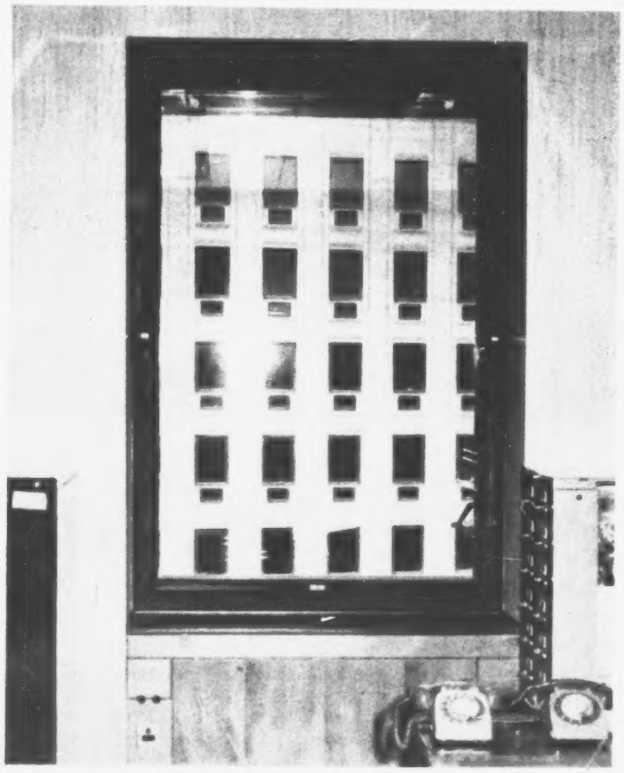

Figure 47
In this airconditioned building the windows are kept locked shut, but they may be reversed for cleaning. A venetian blind works within the double glazing. Telephone and electric points are located below the window.

Curtain walling

A post-war development in window design is the so-called curtain wall, which consists of proprietary dry-fixed light frameworks supported from the building's main structural frame, into which windows and 'wall' panels are inserted as required. Although the daylighting requirements may be met there are likely to be related environmental problems. For example, prevention of weather penetration may depend on mastics whose life is unlikely to exceed 10 to 15 years.[55] In a limited survey of curtain walls, the typical nuisances were found to be wind penetration and rattle, and summer heat gains.[56] Because of the many materials comprised in curtain wall constructions, the prediction of their heat transmission characteristics is complicated. Thermal discomfort (and extremes of hot and cold conditions) is quite common. The total heat loss through a whole curtain wall construction is probably high and there are strong possibilities of interstitial and surface condensation.[57] Such light constructions increase the opportunities for noise penetration.[58]

Orientation and aspect of office buildings

It is usually recommended that office buildings should, wherever possible, be orientated so that the two long sides are exposed to the east and west, ensuring that all offices may have some direct sunlight. When the sun is low this arrangement may cause discomfort due to both glare and heat gains from solar radiation. If open-plan offices are used, then a north-south exposure limits pen-

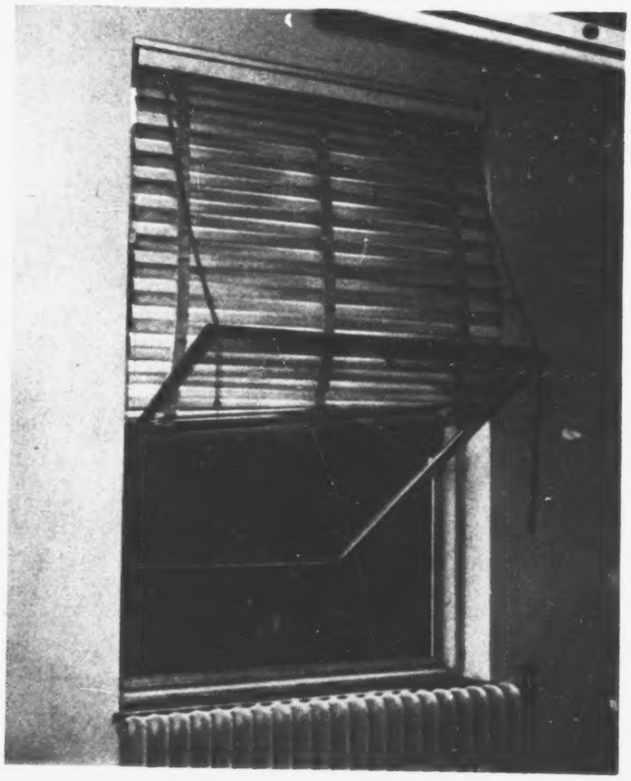

Figure 48
Opening light fouling venetian blinds.

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53. Private communication
54. **Markus, Thomas A:** Element design guide: Screens and louvres: General. Architects' Journal, 1963 (January 2)
55. **Markus, Thomas A:** The glass curtain wall. Architects' Journal, 1958 (January 23)
56. **Anon:** Working details revisited: External non-loadbearing walls. Architects' Journal, 1962 (November 7)
57. See: **Rostron, Michael:** Light cladding, 3: condensation. Architects' Journal, 1960 (March 10)
58. **Committee on the Problem of Noise:** Noise: final report. Cmnd 2056. HMSO, 1963

etration of sun in summer, permits deeper penetration in winter (when direct sunlight may be very acceptable) and minimises the need for and size of sun-shading devices.

Daylighting in the offices in the Survey Sample

Most of the offices in the Survey Sample are comparatively shallow, ie, they were obviously designed to be lit mainly by daylight.[59] The only building in which the electric lighting was *intended* to be used during most of the day was the CIS building. Here, behind the totally glazed exterior, the electric lighting is used freely at all times of the day, winter and summer. Another building in the Survey Sample was an extensive single storey open-planned office accommodating about 600 people, which differs from all the other buildings examined in that it obtains its daylight illumination from plastic rooflights. The electric light in this building is switched on and off in three stages by an automatic photoelectric control. Although the other offices had been more conventionally designed to be lit mainly by daylight, there was a tendency in many of them for the electric lights to be switched on as soon as the staff arrived in the morning and to be left on for the rest of the day.

Many of the difficulties and inconsistencies experienced in measuring daylight in single-storey factories[60] have also been found in surveys of daylight in office buildings. Some of the buildings are at a considerable distance from the Department of Building Science, and so, even if an overcast sky existed in Liverpool, the likelihood of finding the same conditions thirty or more miles away was small. Even when the cloud cover was eight-eighths, most attempts to measure daylight factor were unsuccessful because of rapid variations in sky luminance. In addition, in air-conditioned offices with sealed windows, it was impossible to fix an external reference cell.

Some measurements have been made in spite of these difficulties, on seventy-one desks of a representative area of a top-lit single-storey office building and on fourteen desks of an office on the 15th floor of a side-lit building.[61] The average of one set of readings of daylight factor in the top-lit building was 4.6 percent, with a range of 2.4 to 8.2. Two sets of measurements in the side-lit building were taken on consecutive days, and during both the sky was completely overcast. Yet the second set of measurements differed from the first by between 7 and 30 percent, in spite of generally similar sky conditions. The present state of development of field techniques for measuring daylight factor is quite unsatisfactory and the National Illumination Committee Daylight Steering Committee and Advisory Group has set up a panel to review present knowledge on the subject and, if possible, to propose better methods.

Electric light

General lighting, ie, a substantially even pattern of lighting over the whole working plane, is now the normal installation in offices. It is provided by either (i) a regular pattern of light sources, (ii) lights in continuous strips, or (iii) luminous ceilings.

In Britain, the standard basis for the design of electric lighting installations is (i) calculation of illumination by the lumen method[62] together with (ii) calculation of glare index.[63] This involves decisions (or information) about:

(i) the geometry and dimensions of the room
(ii) the reflectivities of the surfaces of the room
(iii) the choice of lamp
(iv) the choice of fitting
(v) the positioning of the fittings, ie, their spacing, height and orientation
(vi) the use and maintenance of the room.

For the design of an installation which will provide general lighting conforming to the criteria previously discussed, there are two matters of choice which affect the character of the environment – the lamps and the fittings. Considerations affecting the choice between tungsten filament and fluorescent lamps are listed in table 6.

Table 6
Comparison of characteristics of tungsten filament and hot cathode fluorescent lamps for general lighting in offices.

Characteristics	Tungsten	Fluorescent
Efficiency	8-14 lm/watt	27-50 lm/watt depending on colour rendering properties and size of tube, the lamps with the lower efficiency usually providing the higher quality light
Life	Normally taken as 1,000 hours	Normally taken as 5,000 hours
Suitability for colour discrimination	Unsuitable for critical colour discrimination	Range of lamps with different colour rendering characteristics available
First cost of lamps and fittings	Relatively low	Relatively high
Running costs	Relatively high	Relatively low
Heat emission from lighting installation	Relatively high	Relatively low
Lamp especially suitable for:	Highlighting points of interest	General and permanent lighting

Light fittings give either direct lighting (ie, downwards only), indirect (ie, upwards only) or, most usually, a combination of the two – ie, illumination downwards onto the working plane, with a smaller proportion upwards to light the ceiling. Direct lighting is the most efficient in terms of illumination on the horizontal working plane, but it creates strong contrasts of bright light sources against dark ceilings and, possibly, gloom. Indirect lighting is the least efficient system possible, it gives shadowless lighting and eliminates modelling and textured effects, besides making the ceiling the brightest element in the room.

To avoid glare, the average brightness of the surface of a fitting should not be greater than 1,000 ft-lamberts (with a maximum value at any point not exceeding 1,500 ft-lamberts), unless it is screened so that it is not visible within an angle of 45° to the horizontal.[64] A cut-off of the light source can be achieved by (a) the shape and position of the surface of the fitting, (b) by concentric-ring, egg-crate or other diffusers, or (c) by coffering or otherwise shaping or screening the ceiling surface.

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[59] No description of daylighting design methods are given in this report. Some sources of information are:
Building Research Station: Estimating daylight in buildings. BRS Digests (second series) nos. 41 and 42. HMSO, 1963 (December) and 1964 (January)
Hopkinson, R. G: Architectural physics: Lighting. HMSO,1963
Walsh, John W. T: The science of daylight. Macdonald, 1961
Lynes, J. A: Developments in daylight prediction. Light and Lighting, 1963 (May)

[60] **Phillips, R. O:** Natural lighting investigations. Appendix 2.6-1 to: **Manning, P:** The design of roofs for single-storey general-purpose factories. University of Liverpool, Department of Building Science, 1962

[61] See appendix 6.1 for details of daylight surveys

[62] See, for example, **British Lighting Council:** Interior lighting design. (The Council), 1962

[63] **Illuminating Engineering Society:** op cit (7)

[64] **Building Research Station:** Artificial lighting of building interiors: lamps and fittings. BRS digest no. 81. HMSO, 1955 (September)

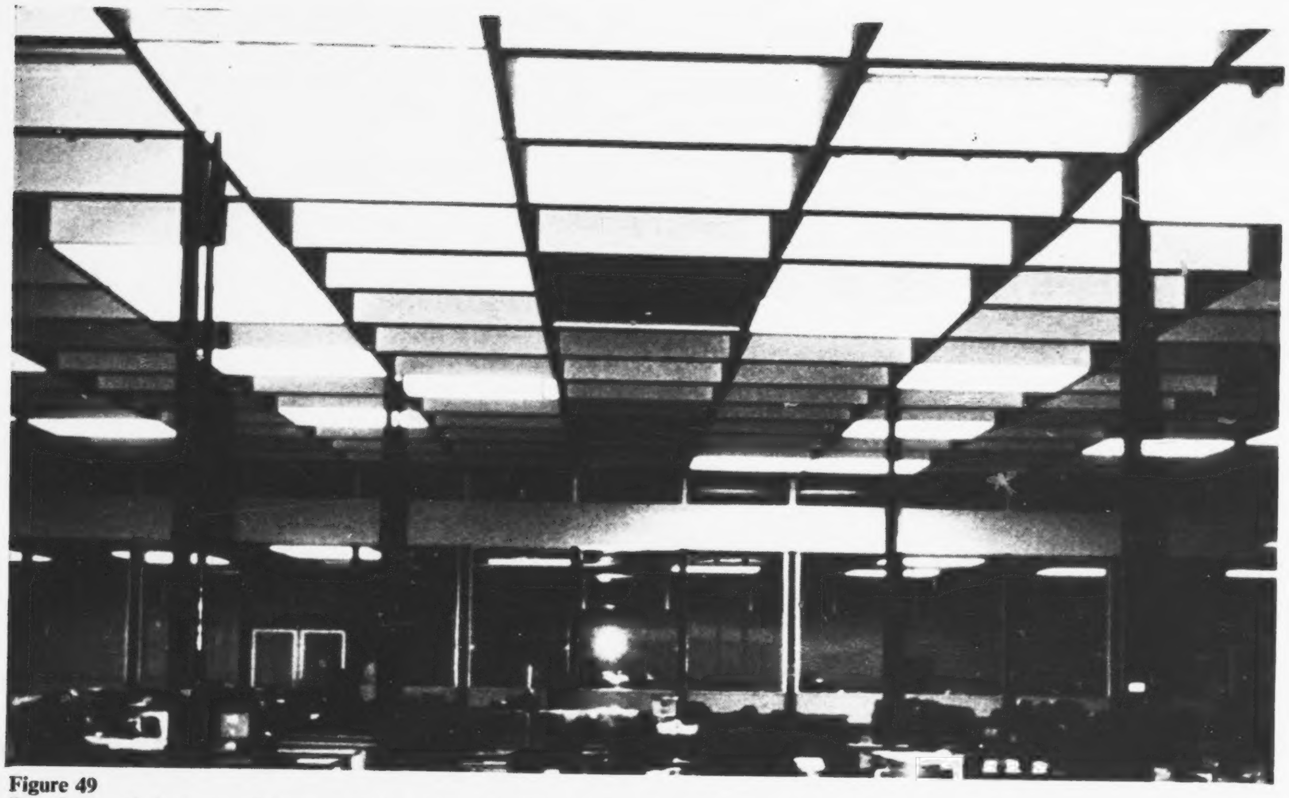

Figure 49
Bare batten fittings cut off from view by design of ceiling construction.

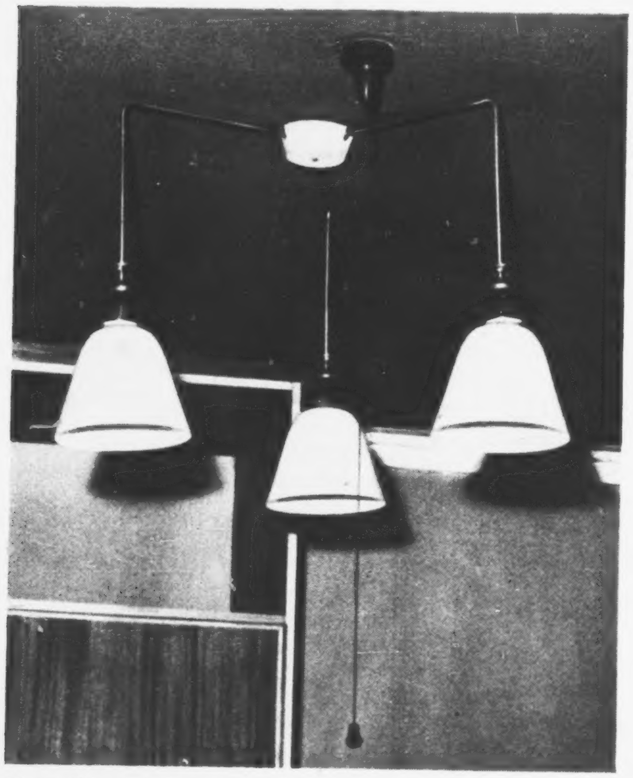

Figure 50
An indirect fitting in a private office has been changed by the user for a direct one in order to obtain a higher working illumination.

To maintain the efficiency of the lamps, the condition of the fitting and wiring insulation, and to reduce the amount of dirt deposited on both lamp and fitting, it is often recommended that ventilation be permitted upwards, through the fitting. This usually allows some light to be spilled onto the ceiling.

Electric light in the offices in the Survey Sample
During this study, surveys of electric lighting were made in six offices. The number of surveys was too few to draw any general conclusions from the results, but they have been useful in indicating the magnitude of the differences which might exist between the standards that managements or designers have intended to provide and those actually achieved.[65]

All the systems examined were installed during the period 1945 to 1962. The mean illumination levels in the four offices with fluorescent installations varied between 19 and 100 lm./sq.ft; the two tungsten installations gave values of 9 and 18 lm./sq.ft. In only one of these offices was the illumination level higher than the IES recommendation of 30 lm./sq.ft for general offices; all the others were lower, some very much so. (But the value of illumination recommended by the IES during the period 1955 to 1961 and applicable to general offices was 20 lm./sq.ft). The three schemes which were designed to provide a known value of illumination failed to do so by between 8 and 27 percent.

A perfectly even illumination is difficult to achieve and, if monotony is to be avoided, is possibly undesirable anyway. But an important requirement in office design is that internal planning and use should be as little restricted as possible, and a substantially even illumination is therefore essential. The IES recommendation of a minimum value of the ratio of E_{min} to E_{max} (ie, 0.7) has been achieved in only one building. This has a fluorescent installation with a mean illumination of 28 lm/sq.ft. The building with the very high illumination levels has the next best ratio of 0.6;[66] the remaining four schemes have values of either 0.4 or 0.5.

The calculation of glare index is a relatively new practice, requiring photometric data which is not yet readily available; it has not been possible to compare the performance of these lighting installations on that basis.

The practice of group replacement of fluorescent lamps has been advocated for several years.[67] Where it is adopted the lamps are changed when their 'residual value' has become so low that it is cheaper to replace them all at once rather than individually as they fail. Half the offices where lighting installations were surveyed use the group replacement method, but they tend to be the larger ones, for the practice is comparatively rare in small offices. In two of the offices lamps are replaced after the expiration of a definite period of time. This has two advantages: the work can be planned in advance and it can also be timed to coincide with cleaning, thus reducing the cost.

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[65] See appendix 6.2 for further details of these surveys
[66] At its 'high' illumination stage. The value for the 'low' illumination stage is 0.2
[67] **Robinson, W.** and **Strange, J. W**: The maintenance of lighting installations. Trans Illum Eng Soc. (London) 1955, 20 (5).

In a third office, a complicated procedure for bulk replacement has been laid down. It includes failure replacement at four weekly intervals and wholesale replacement (except of lamps previously replaced individually) at the end of the lamps' economic life. In the fourth fluorescent installation the lamps are replaced individually when they fail.

In the two offices which are lit by tungsten filament lamps the lamps are replaced individually. But group replacement is not usually adopted for this type of lamp, possibly because lamps can be replaced by unskilled people.

In all the offices the light fittings are cleaned on a systematic basis, mostly at six-monthly or longer intervals by contractors working outside normal office hours. Fittings are normally washed in warm water containing soap or detergent; in two offices they are treated with an antistatic solution. Ventilated fittings have been installed in only one building. Yet tests performed in the U.S.A. on flourescent fittings have shown that after a period of twelve months, the percentage light output of the ventilated fittings was 96 percent of the original, but of the unventilated fitting only 72 percent.[68]

It was stated earlier that the desirable pattern of brightness in a room is one where the visual task is the brightest part and where there is a gradation downwards from this to the more distant surfaces. The brightness of a surface depends upon the amount of light allowed to fall upon it, and its intrinsic qualities of reflectivity.

Light colours were used for the walls and ceilings of all six offices in which the lighting surveys were made, but their cleanliness varied considerably. The reflectivity of all the ceilings was estimated[69] to be within the range 64 to 75 percent; the reflectivity of the walls was measured and found to be between 43 and 63 percent. Excessive brightness contrasts are liable to be created by light-coloured tasks seen against dark desk tops; in general, brightly polished desk tops should not be used because they may cause reflected glare. In most of the offices desk tops were matt, with reflectivities of between 15 and 48 percent. There was a small group of desks in one building which had dark green, glossy surfaces, where the reflectivity was as low as 5 percent, but they were only in temporary use.

The most common types of decoration were semi-gloss or emulsion paint. The external walls of one building were entirely glazed and only the ceiling and partitions had to be decorated. The ceiling was metal with a stoved on finish and the partitions were covered with plastic sheeting, so both were easily washable. In only one building was wallpaper used in the general clerical areas and the management said that 'it is treated with more respect and therefore keeps in a good condition longer than paint'.

So far as could be judged by relatively inexperienced observers, none of the installations were uncomfortably glaring. In most of the offices the colour of the electric lighting was pleasant but in one an irregular combination of warm white and daylight was used which gave a rather untidy appearance. In another, because the fittings were flush with the ceiling, very little light 'spilled' onto that surface and it looked dark and perhaps dirty.

Clerical workers needs of a visual environment

In the system of permanent supplementary artificial light (PSALI) which the Building Research Station has recently recommended for use,[70, 71, 72] it is assumed that daylighting is, in itself, an important condition for a good working environment. The replies to a questionnaire about the working environment in their new building addressed to the 2,500 head-office staff of the Cooperative Insurance Society show that such an assumption is in line with common belief. The response to a question which asked whether it was felt important to be able to see out of the office even if there was plenty of artificial light to work by was overwhelmingly that people did feel this to be important. Only twelve percent considered it unimportant.[73]

Hopkinson and Longmore have referred[74] to what they believe to be the great psychological need that people have for daylight. They instanced, as an extreme example of the effects of daylight deprivation, the case of the Scandinavian neurosis 'Lapp sickness', and say that 'This kind of evidence is by no means conclusive, but if one wants to believe that daylight is necessary for human well-being, it reinforces that belief'. In framing subsequent recommendations on lighting and building form they then take it as axiomatic that a physical predominance of daylight illumination is a necessary condition for a suitable environment for clerical workers. This is probably an accurate reflection of the assumption made in most current office building design, and so far it has not been seriously questioned.

It was apparent from the replies to another question that people feel there are clear qualitative differences between daylight and electric lighting. Asked whether they felt it to be as good for their eyes to work by electric light as by daylight, only 13 percent replied 'yes'. 18 percent gave a neutral answer and 69 percent replied that electric light was not as good as daylight.

On the face of things, it would therefore seem that designers would be well advised to ensure that daylight is the dominant feature in the lighting of working spaces, for it appears to be a necessary condition for producing a subjectively satisfactory environment. If people feel they have a need for something, they will feel discontented or deprived if they are aware that it is not present.

However, what if people are unable to distinguish whether they have or have not what they think they need? In a wholly glass-clad but deep office building the respective contributions to the total illumination of daylight and electric light are not readily apparent, yet they must be established before the relationship between actual physical conditions and the beliefs and attitudes connected with the presence of windows, and with natural and artificial lighting, can be examined.

As the questionnaire responses showed that daylighting was regarded as being so much better for the eyes than artificial lighting, and that being able to see out of the building was rated as being very important, it seemed that distance from a daylight source should be regarded as one of the most prominent factors making for the satisfactoriness of the individual's working environment. Accordingly, an objective appraisal of the individual's ability to discriminate between daylight and artificial light has been made.[75] If the individual is unable to make a satisfactory discrimination then, clearly, this will influence the *prima facie* case for high levels of daylight illumination which currently dictates the need for designing narrow buildings, or narrow spaces arranged round open light wells or courts.

The setting of the investigation was the new head office of the CIS. This is a very deep office building with continuous floor-to-ceiling glass curtain walling. The electric lighting installation consists of fluorescent fittings inset in the ceiling with a plastic 'egg crate' flush with the ceiling surface. The light fittings are in continuous rows at 5 ft 2 ins intervals, and they are in constant use. The sample of individuals whose discrimination was being appraised was composed of general clerical workers and did not include any such specialised groups as typists or machine operators. All the workers were working in open-plan office space and had an uninterrupted view of the window walls.

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[68] Test referred to by **Robinson, W.** and **Strange, J. W**: op cit (67)

[69] See appendix 6.2

[70] **Hopkinson, R. G.** and **Longmore, J**: The permanent supplementary artificial lighting of interiors. Trans Illum Eng Soc. (London). 1959, 24 (3) 121-148

[71] **Hopkinson, R. G.** and **Longmore, J**: The use of permanent supplementary artificial lighting. Architects' Journal, 1959 (October 8)

[72] **Building Research Station**: The permanent supplementary artificial lighting of interiors (PSALI). BRS digest no. 135. HMSO, 1960 (June)

[73] See chapter 10

[74] **Hopkinson, R. G.** and **Longmore, J**: The use of permanent supplementary artificial lighting. op cit (71)

[75] **Wells, B. W. P**: Subjective responses to the lighting installation in a modern office building and their design implications. Building Science, 1965, 1 (1)

The experiment consisted essentially of relating stated beliefs and subjective experience of the subjects' physical conditions, so that both questionnaire and physical measurement techniques were necessary. The staff were asked to complete a questionnaire during the course of a morning. The experimenter made physical measurements of the lighting and obtained the appraisals during the same morning. The questionnaire contained questions dealing with a wide variety of environmental topics but was specifically the vehicle of three questions dealing with beliefs about the physiological value of daylight, the importance of a view from the building, and the comfort of the combined electric and daylight illumination. The relative proportions of electric light and daylight were estimated by each worker in a face-to-face situation during which the total level of illumination from both sources was measured by the experimenter.

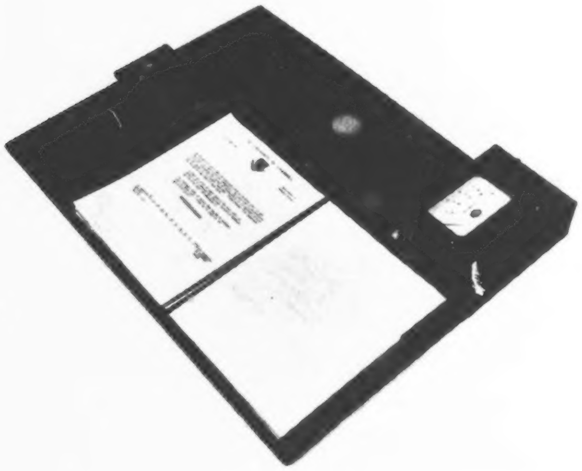

Figure 51
The photometer and lighting judgement scale.

The photometer had, for convenience and in order to provide a standard stimulus background to the judgement forms, been mounted on a rectangular board and painted pale grey so that its reflectivity was similar to that of the desks on which the subjects worked. On the board was a pile of typed quarto forms, and beside these, a pile of completed forms face-down, which gave a 10 inch x 16 inch area of white paper. The typed instructions on the left-hand pile had to be attended to, so the task simulated a normal clerical procedure quite closely.

The document for the subject's attention asked him to try to estimate the relative amounts of daylight and electric light illuminating the form, and to do this by using a scale ranging from zero to 100 percent (no daylight to total daylight). In each case, the experimenter made sure that, before the estimates were made, the respondent had correctly interpreted the instructions and understood that the level of illumination in the building depended on both sources of light. The experiment took place during August at a time when the sky was dull and almost uniformly overcast.

The daylight illumination available at the time of the experiment at each working position was found by subtracting measurements made at night time of electric lighting only from the combined measurements of daylight and electric light. From this it was possible to compare the actual percentage of the illumination represented by daylight with the worker's subjective estimate of the same thing. One value was then subtracted from the other, thus giving the amount and direction of subjective error. The data required for the analysis was completed by measuring the distance of each of the desks from the nearest daylight source.

Analysis of the data has shown that where electric light is used permanently, then the further an individual works away from the nearest daylight source the greater will be his tendency to over-estimate the proportion of daylight to electric light (figure 52). It was also found, from a comparison of staff's desk positions and their replies to a question on the relative goodness of daylight and artificial light for the eyes, that distance from the nearest window has no influence on the belief that artificial lighting is not as good for the eyes as daylight.

Similar cross tabulation of desk positions with replies to a question of whether it is important to be able to see out of the office (even if there is plenty of artificial light to work by), has shown that the strength of a person's subjective estimate of the importance of being able to see out of the office is not related to his distance from the nearest window. Further, it was found that there was no difference between the comfort of the illumination over a very great range of physical differences in both total illumination level and the amount of direct daylighting.

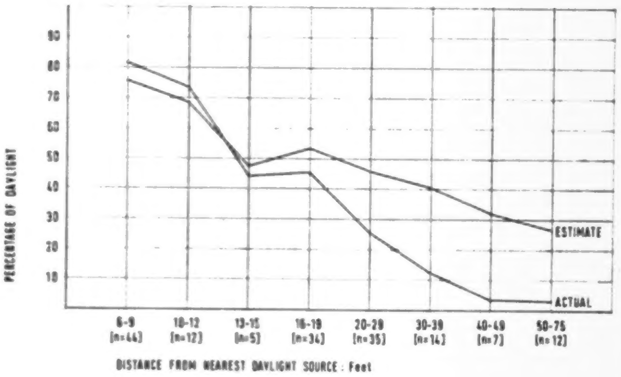

Figure 52
Study of clerical workers' ability to discriminate between daylight and electric light: plot of actual percentages of daylight and subjective estimates of percentage at increasing distances from nearest daylight source.

There was some temptation to write into the questionnaire some such enquiry as, 'Do you feel that you receive a sufficient proportion of daylight where you work?' On face value, this would have answered a most important practical question, ie, that amount of direct daylight required in order that an office worker shall find his lighting environment satisfactory. Nevertheless such a question was not included because it was felt that, as there were obvious differences in the proportion of daylight received at different distances from the windows, it would be likely to provoke responses that were based on the apparent fact of having more or less daylight than other people, rather than upon the personal satisfactoriness of the visual environment.

It might have been supposed, from the great proportion of questionnaire replies dealing with the importance of daylight, that the respondents would be very sensitive to its presence or absence. On the other hand, factors were at work making an accurate subjective estimate of it exceedingly difficult. The subjects were asked to estimate the relative amounts of daylight and electric light illuminating the sheet of paper on which the scale was drawn. In the absence of visual cues like shadows, and where there are no gross differences in the spectra of the two light sources, such a judgement is, of course, nearly impossible. In fact, without a single exception, the subjects looked up and around in the direction in which they were facing (ie, towards the windows) before making a judgement. The real judgement therefore seems to have been made in the terms of apparent brightness.

There appear to be two significant factors influencing the way in which the judgements were made. In the first place there were floor to ceiling windows which provided large bright areas presumably suggesting important sources of illumination. Secondly, the artificial lighting system produced an unbroken stretch of even illumination which provided, except in the case of those people very near the windows, very much more light than the windows themselves. Physiological adaptation would therefore take place in terms of the electric lighting rather than the daylighting. This could be predicted to have two consequences: firstly, that the large windows and the light reflected on vertical surfaces (which would, in fact, be a mixture of electric light and daylight) would be sufficient to give those people who were comparatively deprived of direct daylight the impression that they were not so deprived; secondly, the brightness of the fluorescent lighting, compared with the windows themselves, would give the same people the subjective impression of being in a brightly illuminated area. The fact that people's ideas about the physiological advantages of daylight, and of the need for a view to the exterior, are independent of a physical context reveals attitudes or prejudices rather than a genuine subjective response to the environment. It is likely that these attitudes are based upon some common factor, perhaps custom, or experience of older and less successful lighting solutions, such as small windows or poorly designed or manufactured electric light fittings. Whatever this common factor might be, it appears to be of little consequence in environments such as the one examined, where the individual is not able to distinguish the existence of conditions which in fact infringe these sensibilities.

The findings of this investigation would seem to raise some interesting questions connected with the Building Research Station's PSALI recommendations and the assumptions on which they are based.

The BRS recommendations have been proposed to provide a lighting environment in which daylight is the principal source of illumination and in which, assuming that a satisfactory minimum illumination exists, the emphasis is placed on brightness distribution rather than illumination levels. So long as a sufficient level of illumination is available for doing a particular task, then the causes of discomfort in the visual environment will largely turn on such considerations as glare, either from intense light sources like nearby windows, or from contrasts in the brightness of different parts of the room or working surface. The result of such conditions will be unfavourable physiological adaptation of the eyes. That is to say, the influence of comparatively bright areas in the visual environment is to push up the level of adaptation so that objects and areas which are in fact well illuminated, give the subjective appearance of darkness and gloominess.

The principal PSALI method of reducing contrast within a room is by grading the level of artificial lighting from the inside of the room towards the windows, the highest levels of artificial light being furthest from the windows. To keep the brightness contrast fairly low it may be necessary to use '. . . smaller windows than would otherwise have been installed, and it may also mean the provision of built-in glare shields'.[76] With high levels of artificial illumination inside the building, there is less need for a large daylight component and apart from the windows being made smaller, it is possible to reduce the height from which the daylight penetrates the building – in other words, to have lower ceilings. The economic advantages of lower ceilings, reduced running costs and higher site utilisation have been given as cost savings which may be balanced against the capital and running costs of PSALI.[77]

The conception of PSALI is a bold one, for it goes beyond merely making recommendations for lighting to an intimate concern with the design of the building itself. However, the Unit's investigation, if confirmed, would make it possible to have even deeper buildings than those envisaged by BRS. The Station's digest says, 'This is a system in which daylight supplies a dominant source of lighting, and carefully designed artificial lighting adds supplementary illumination to the less well-lit parts of the building. It is important to stress the dominance of the daylighting both in quantity and direction – the artificial lighting is *supplementary*.' The conditions examined for the Unit's experiment included the responses of people seated from between fifty and seventy-five feet away from the nearest window, the daylight component at these distances tending to be in the region of 1 lm./sq.ft or less. Therefore, by BRS's own definition, it follows that the PSALI solution is appropriate only to shallow buildings whose site utilisation will be of a lower order than that of the particular building considered here. Indeed, PSALI has been described as being applicable to 'Single-side lit rooms of 20 to 40 ft depth or two-side lit rooms up to 80 ft in depth'.[78] It is possible, of course, that PSALI would be suitable at greater depths, and that it is merely its premises which need revision. However if the experimental findings of this present research that the satisfactoriness of the lighting environment was not significantly influenced by distance from the nearest window are accepted, then it may be assumed that building and lighting designs such as the ones adopted for the CIS building are at least as satisfactory as PSALI could be expected to be. The CIS also has a comparatively low ceiling (10 ft) and therefore attains the reduced building and heating costs (besides the high site utilisation) which are claimed as typifying PSALI installations.

In a discussion of the mechanics of PSALI, the following statement is made: 'The necessary levels of supplementary light have to be determined by the requirement to raise the brightness of these remoter parts of the room until there is no longer any sensation of lack of light'.[79] In practice, in the case studied at the CIS building, as in most other large office blocks visited by the Unit, clerical workers are seated facing either in the direction of the nearest window, or with it to their left hand side. The appearance of gloominess of those parts of the room distant from the windows depends upon viewpoint. The two illustrations (figures 53 and 54) show very clearly the subjective differences created by the direction in which workers are facing.

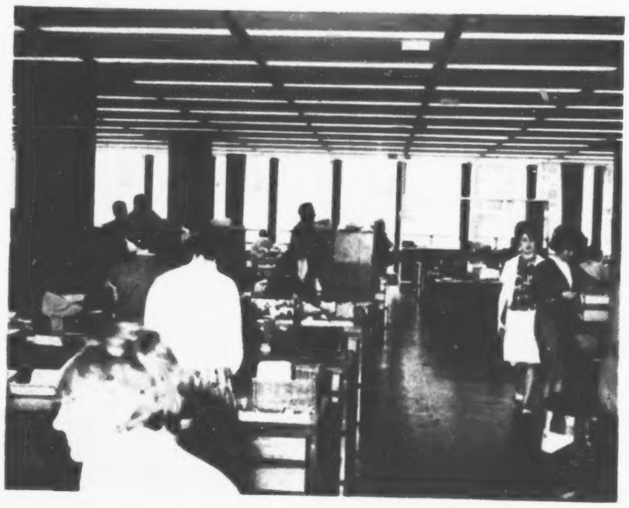

Figure 53
Experimental area viewed from inside towards windows.

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76. **Hopkinson, R. G.** and **Longmore, J**: The permanent supplementary artificial lighting of interiors: op cit (70)
77. For example in: **Building Research Station**: op cit (72)
78. **Hopkinson, R. G.** and **Longmore, J**: The use of permanent supplementary artificial lighting. op cit (71)
79. **Building Research Station**: op cit (72)

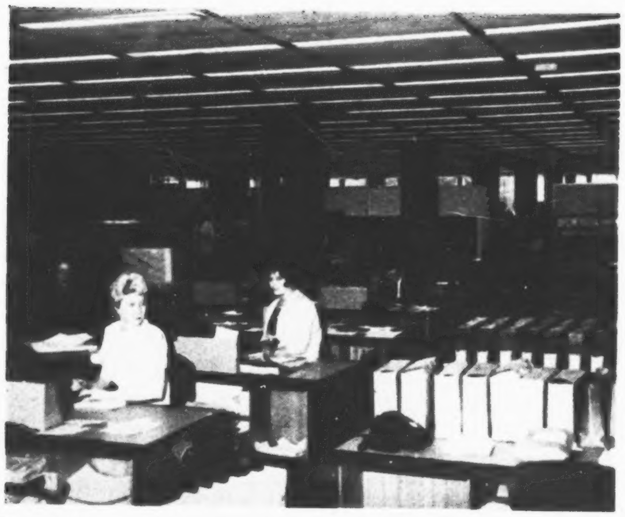

Figure 54
Experimental area viewed from windows inwards.

Everybody feels that daylighting is necessary to their well-being, but the factual basis for this has not yet been demonstrated. Though it is possible to sympathise with the belief, it should not be allowed to pass unquestioned to the status of an axiom of building design. In framing their recommendations Hopkinson and Longmore have treated it in this way and, in specifying a dominance of daylight, have imposed severe limitations on the design and structural form of office buildings. It is very likely that buildings can be built much more deeply than has yet been regarded as desirable and still produce satisfactory conditions.

Windowless environments

A logical next step from permanent supplementary electric lighting may be the creation of permanently windowless environments. In the absence of knowledge of people's need for daylight, the defence of windows rests largely on emotional grounds. In 1960, when the British Lighting Council organised a one-day conference on the theme 'Is daylighting really necessary?'[80] the main speakers were able to present a stronger case for design which disregarded daylighting considerations than was the unorganised 'opposition' to refute it. No windowless offices in Britain are known, but there are several modern windowless factories, at least one of which has been constructed for an industry which does not have a technical need for windowless conditions. Windowless design for factories for economic rather than technical reasons is becoming common in several East European countries; it has, of course, been common in the U.S.A. for many years and experimental windowless *schools* are now in use there.[81] A recent Russian paper[82] stated that 'windowless buildings must be made subject to more stringent requirements with respect to lighting and conditions of health than buildings with natural daylighting'. Possibly for the same reason the IES Code[83] suggests that a computed value of illumination may be increased by a factor of 1.5 to take account of 'special practical circumstances' when the interior has no natural lighting.

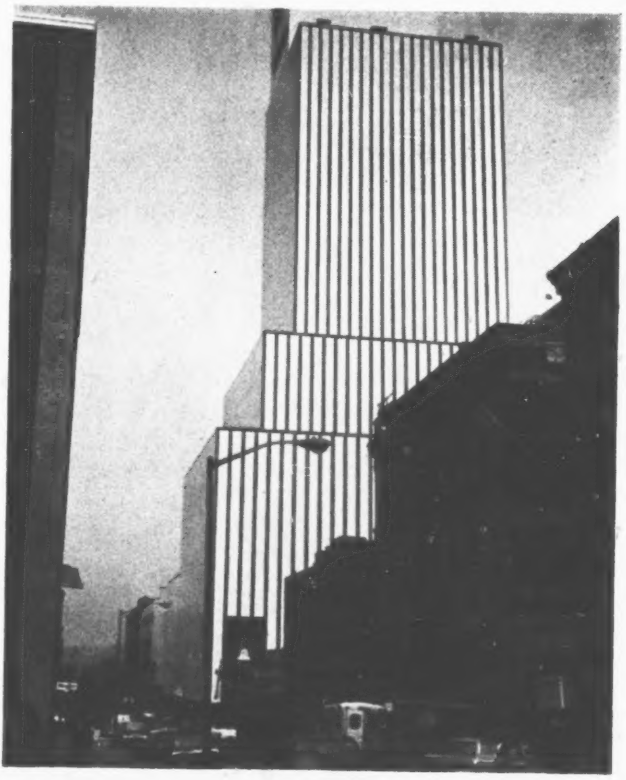

Figure 55
Windowless office building in New York.

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[80] The conference was reported briefly in the Architects' Journal, 1960 (May 5) pp 677-8

[81] **Larson, C. Theodore:** School environments research and the evaluation of windowless classrooms. Paper in: School Building Research. Publication no. 1008, Building Research Institute, Washington DC. (The Institute), 1963

[82] **Zoz, N. I:** K voprosu ob iskusstvennom osveshchenii promyshlennykh zdanii bez estestvennogo sveta (The problem of the artificial lighting of factory buildings with no natural daylighting). Svetotekhnika 1960, 6 (11) (Building Research Station library communication no. 1100. 1961, September)

[83] **Illuminating Engineering Society:** op cit (7)

Chapter 7
The thermal environment

People have to maintain a heat balance with their environment: they lose heat from their bodies by radiation, convection and (via perspiration and respiration) evaporation, the rate at which this happens depending on the environment and their activity. The problem of the thermal environment in offices is a matter which varies with the season: buildings are heated in winter (and people may wear more clothes) so that the rate of loss of heat which would occur in a natural environment is reduced. In order to provide comfortable conditions in summer, the rate of heat loss may have to be increased artificially, for example, by introducing currents of air, or by cooling the air.

Previous surveys of the thermal environment in offices

It is only since the war, with the more general use for office buildings of light systems of cladding and an extensive employment of glass, that the summer thermal problem has become conspicuous. Most reported surveys of the thermal environment within offices have dealt only with conditions during winter.

The study panel for the civil service report[1] found that in the nine modern commercial offices they visited the temperatures maintained varied between 64 and 70° F. Temperatures in buildings where the Ministry of Works was responsible for heating were commonly 60°F (which was a governmental wartime standard). In the commercial offices natural ventilation via windows was usually supplemented by forms of mechanical ventilation to some parts of the buildings. Government offices were usually ventilated entirely by natural means. The report recommended that the most generally comfortable temperature in offices was 65°F, and that airconditioning[2] was seldom necessary.

A study was reported in 1954 of a correlation of temperature measurements in 'about 55 rooms' in two buildings with the occupants' assessment of the conditions.[3] This indicated that the most generally acceptable comfort zone is likely to be between 64 and 72°F, that women appear to be more critical than men of temperature extremes, but prefer slightly higher temperatures, and that they are increasingly likely to complain as the temperature falls below 64 or 65°F.

Although they are better adapted than men to meet changing environmental conditions, women are more sensitive to '. . . those changing conditions that tend to produce a cooler environment'.[4] Part of this greater sensitivity might be explained by physiological differences, but variations in the '. . . quality, amount and design of clothing is a very significant factor.' Bruce refers to work by Yaglou and Messer[5] which demonstrated that men and women wearing similar clothing were comfortable in similar environments.

In 160[6] out of 913 suites of offices in Liverpool[7] there were 'inadequate' means of maintaining temperatures at 65°F, and 180 complaints of draughty conditions in 'colder' weather.[8] Sixteen cases of 'inadequate' means of ventilation were reported.[9] 120 underground offices and workrooms (excluding shops) were reported and their use was '. . . deplored unless they are exceptionally commodious and are provided with a really effective airconditioning system . . . they are often damp, cold, dusty, badly ventilated and depressing . . .'.[10]

Eleven out of fifty offices in Barrow[11] showed temperatures below 65°F, two being below 62°F. Old and dirty electric bar radiator fires were found to be used frequently; enquiries revealed that women wanted higher working temperatures than men and auxiliary equipment was often provided for this purpose, though it might be used only during the early part of the week before 'the central or other general heating gave sufficient temperature.'

In the City of London, '. . . every conceivable type of heating apparatus was encountered . . . except . . . the coal fire or stove'.[12] There was no heating in any of the offices between June and September. A sample of measurements taken in 290 offices during March and April 1962 showed that 63 percent were in Black's comfort range of 64 to 72°F,[13] but there were nearly 9 times as many measurements above 72°F as there were below 64°F. No attempt was made to seek opinions from office

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1. **Study Group appointed by H.M. Treasury:** Working conditions in the Civil Service. HMSO, 1947
2. The term airconditioning is sometimes used incorrectly when mechanical ventilation is intended. Airconditioning is 'The process of treating air so as to control simultaneously its temperature, humidity, cleanliness and distribution to meet the requirements of the conditioned space'. (Reprinted by permission of: **American Society of Heating, Refrigerating and Air-Conditioning Engineers:** Heating, ventilating and air conditioning guide 1960. (The Society) New York, 1960 Bi-annual publication). Air-conditioning involves heating, refrigeration, washing, de-humidification and filtration
3. **Black, Flora W:** Desirable temperatures in offices: a study of occupant reaction to the heating provided. J Inst Heat Vent Engrs. 1954 (November)
4. **Bruce, W:** Man and his thermal environment. Technical paper no. 84 of the Division of Building Research, (NRC 5514). National Research Council (of Canada). (The Council), Ottawa. 1960 (February)
5. **Yaglou, C. P.** and **Messer, A:** The importance of clothing in airconditioning. J Amer Med Assoc. (October 11) 1941 **117** 1261-1262
6. The original is not precise, and it is not clear whether it is individual rooms or suites of rooms which is intended
7. **Wattleworth, W. H:** Unfinished business in environmental health. Royal Society of Health Journal, 1958 (May-June)
8. Criteria not stated
9. Criteria not stated
10. **Wattleworth, W. H:** op cit (7)
11. **Nelson, I. D. M.** and **Morse, R. J:** A pilot study of office accommodation. The Medical Officer, 1960 (September 9)
12. **Robinson, Alan:** Working in the City: the interim report of a survey. City of London Health Department, 1962 (December)
13. **Black, Flora W:** op cit (3)

workers of the temperatures they desired but the experimenter considered that if the temperatures found had proved uncomfortable the office staff had only to open their windows (which they did not do) to secure a reduction. In sixty percent of the offices *all* windows were shut.

The thermal measurements taken by Robinson during the period June to September provided a somewhat similar distribution to those taken in winter. It is not possible to infer the actual *comfort* conditions which existed.

Summer temperatures and ventilation at all seasons were found to be the least satisfactory features of mechanised offices.[14] Machine rooms warmed up more rapidly than clerical spaces, the temperatures in which varied more widely, often from uncomfortably low levels to peaks above 85°F. Temperatures were 'close to the point of optimum comfort' during the greater part of winter days.

Writing in 1964, and drawing upon a number of BRS surveys of offices, Langdon and Keighley[15] reported a general finding that few offices are not heated sufficiently, whereas unsatisfactory ventilation and uncomfortable summer conditions, already reported in respect of mechanised offices, were more generally experienced. Over 40 percent of the occupants of modern offices surveyed in London found their offices too hot in summer. In offices with particularly bad combinations of environmental conditions this proportion of staff experiencing discomfort rose, for example, to 66 percent of the total staff when their offices were sited on main streets with south-east to south-west aspect and had more than nine-tenths of the external wall glazed.

Legislation

Standards for the thermal environment prescribed in office legislation[16] are either so low that they would be exceeded in almost any modern building or couched in very general terms. Thus, 'Effective provision shall be made for securing and maintaining a reasonable temperature . . .'. Where the work does not involve severe physical effort a temperature of less than 16°C (60.8°F) is not considered reasonable after the first hour. The Minister has power to make regulations varying this standard. No method of heating may be used which allows any injurious or offensive fumes to escape into the room and methods of heating which are considered to be injurious may be prohibited by regulation. A thermometer has to be provided in a conspicuous position on each floor. 'Effective and suitable provision shall be made for securing and maintaining, by the circulation of adequate supplies of fresh or artificially purified air, the ventilation of every room . . . in which persons are employed to work.' Standards of ventilation may be (but have not yet been) prescribed by regulation.

Requirements for a pleasant thermal environment

The make-up of a thermal environment, which besides satisfying human physiological needs, is also pleasant to experience, can be expressed only in general terms. Perhaps the best statement is by Bedford who summarised the requirements in the following way.[17]

'(i) A room should be as cool as is compatible with comfort.

(ii) There should be adequate air movement, but there should be no local draughts. At the room temperature customarily maintained in winter in Great Britain the velocity should be about 30 ft/min; velocities below 20 ft/min tend to cause feelings of stuffiness. In summer months, or in hot factories, higher rates of air movement than those mentioned are desirable.

(iii) The air movement should be variable rather than uniform and monotonous, for the body is stimulated by ceaseless change in the environment.

Bruce has observed that this is an assumption which is usually made, but that actual physiological observations have not been made to substantiate it.[18]

(iv) The relative humidity of the air should not exceed 70 percent, and should be preferably much below that figure.

Page, in a review of human thermal comfort, has suggested that relative humidities between 30 and 70 percent are 'normally satisfactory'.[19]

(v) The average temperature of the walls and other solid surroundings should not be appreciably lower than that of the air, and should preferably be higher. The combination of cold walls and warm air often causes feelings of stuffiness.

In practice it is rarely possible to ensure that the mean radiant temperature is higher than air temperature. Langdon and Keighley[20] *say that, with noise, 'stuffiness' was the worst feature of the offices covered by all the BRS user surveys. They remark that although the subjective experience of stuffiness is well known, it is not yet possible to define it in terms of thermal conditions.*

(vi) The air at head level should not be distinctly warmer than that near the floor, and the heads of the occupants should not be exposed to excessive radiant heat.

Bruce[21] *refers to a 'generally accepted practice of allowing not more than a 5 deg F air dry bulb temperature difference between head and feet levels.' Elsewhere in his same paper Bedford mentions his own conviction that the difference should not exceed this figure and, preferably, should be less. Chrenko*[22] *has shown that sources of high level radiation should not elevate the mean radiant temperature above 65°F by more than 4 deg F. It is generally agreed that variations in temperature over the whole area of a working space should be small.*

In addition, the air should be free from unpleasant odours'.

This requirement, more specifically the avoidance of body odours, is the normal basis for recommended rates of ventilation for winter conditions.[23]

Thermal comfort, it is seen, depends on a complex of factors, mainly air temperature and vertical temperature gradient, air movement, rates of air change, relative humidity, radiant temperature and ventilation.

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14. **Langdon, F. J:** The design of mechanised offices. Architects Journal, 1963 (May 1)
15. **Langdon, F. J.** and **Keighley, E. C:** User research in office design. Architects' Journal, 1964 (February 5)
16. Offices, Shops and Railway Premises Act, 1963. HMSO
17. **Bedford, T:** Comfort in relation to warmth and ventilation. J Inst Heat Vent Engrs. 1954 **22** 85-114
18. **Bruce, W:** op cit (4)
19. **Page, J. K:** Human thermal comfort. Architects Journal, 1963 (June 19)
20. **Langdon, F. J.** and **Keighley, E. C:** op cit (15)
21. **Bruce, W:** op cit (4)
22. **Chrenko, F. A:** Heated ceilings and comfort. J Inst Heat Vent Engrs. 1953, **20** 375-396
23. **Institution of Heating and Ventilating Engineers:** Guide to current practice. London (The Institution), 1959

Thermal indices

Since the thermal environment, as experienced by people, consists of the inter-related effects of several variables, it is not sufficient to specify only one, although in practice this is the procedure commonly adopted. Many attempts have been made to devise an index which will represent in one figure the composite effect at any one time of the different variables and there are at least thirteen different indices in use in various parts of the world and for different purposes.[24] In Britain the best known warmth indices are corrected effective temperature (CET) and equivalent temperature (EqT). Equivalent temperature only incorporates three of the four basic variables: air temperature, mean radiant temperature and rate of air movement, but it is commonly accepted in this country as being suitable for the specification of comfort conditions in winter, ie, when body heat loss is not being controlled by evaporation. Corrected effective temperature takes account of air movement, relative humidity and (by the use of a globe thermometer) radiation and air temperature.

Conventional standards for the thermal environment

The specification of a thermal environment then, is a complicated matter. Normally legislative, departmental and recommended standards do no more than suggest air temperatures and, possibly, ventilation rates. Clearly, this is no more than part of the thermal problem although, in Britain's temperate climate, it is perhaps the most important one. A more general (and with some types of construction, serious) objection is that only minimum temperatures applicable to *winter* conditions are specified; summer thermal conditions and their possible consequences are either not foreseen or ignored. In giving evidence to the Gowers Committee, some representatives of clerical workers advocated minimum (winter) air temperatures of 65°F[25] but the Report as published recommended only the standards of the Factories Act[26] (60°F after the first hour). A value close to this (18°C or 60.8°F) has been incorporated in the new Act.[27] The Code of Practice for Heating and Thermal Insulation[28] recommends 65 to 67°F for general and private offices. The Code of Practice for Ventilation[29] recommends minimum rates of fresh air supply of between 420 and 1,000 cu.ft per person per hour depending on the volume of office space available to each person. The IHVE Guide[30] suggests 65°F for general and private offices with two air changes per hour (1½ to 2 for private office). A writer in the Institute of Directors handbook on office design[31] states that, while air temperatures in the range 65 to 68°F have been the customary design values, the sedentary nature of office work and the present-day tendency to wear light clothing suggests a more suitable range of 65 to 70°F (where the upper end of the range will be particularly suitable for women and people over 40 years of age); temperatures at the lower end of this range will be more acceptable when systems of radiant heating are used. In the Civil Service there is an understanding that heating should be provided to maintain room temperatures of up to 65°F with 60°F as a minimum. One large industrial organisation[32] has decided that an acceptable temperature for sedentary workers is between 65 and 68°F, though consideration has to be given to humidity and air flow and the different requirements of men and women.

Criteria for determining the beginning and end of the heating season have been established for the Civil Service.[33]

Winter thermal comfort

In the introduction to her paper, Black[34] reviewed a number of comfort zones which have been advanced for the thermal environment, including equivalent temperatures of 58 to 66°F,[35] 62 to 66°F[36] and 66 to 72°F.[37] It has been suggested[38] that the range of *air temperatures* put forward by Bedford (60 to 68°F) may be '. . . a bit low, especially if air temperature is considered in isolation . . .' for today's conditions. Bedford's work was primarily with industrial workers and if changes in dress habits during the past 30 or so years are taken into consideration then his values of 58 to 66°F EqT are on the low side for today's office workers.

Draughts are a very common cause of complaint in offices. Bruce[39] quoting Houghten et al[40] described three types of draught which are 'any local sense of cooling . . . caused either by an excessive movement of air of normal temperature, by air having a normal velocity but a lower temperature, by excessive radiation from the body to a cold surface, or by any combination of these three effects . . .'. Bruce doubts whether people are capable of distinguishing between the last two causes. It is likely, too, that few office workers or their managements realise that sitting next to cold surfaces like filing cabinets or windows can create these sensations.

The management of one office in the Survey Sample were concerned that relative humidities in their building were low. Their staff was in good health but they feared the possibility of a virus infection which might, they thought, occur if people's throats tended to be too dry. Measured RH's in this building were of the order of 30 percent, ie, at the lower end of Page's acceptable range of 30 to 70 percent. Unfortunately, in very cold dry weather, there is no simple method of control of relative humidity in buildings which depend upon natural means of ventilation.

Summer thermal comfort

Summer thermal problems are experienced in many modern factories[41] and occur in other building types including offices[42] and schools. The optimum temperatures for comfort for factory workers in summer have been found to be of the order of 2 to 4 deg F higher than those for winter.[43] People become acclimatised to the

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24. Thirteen indices are listed in **Webb, C. G:** Thermal comfort and discomfort: a review. Indian Constructional Journal 1961 (December) and 1962 (January) (A BRS paper). See also: **Givoni, B:** The nature and application of thermal indices. 'In the field of building' bulletin no. 73-74. Technion - Israel Institute of Technology. Haifa, 1960
25. **Home Office** and **Scottish Home Department:** Health, welfare and safety in non-industrial employment. Hours of employment of Juveniles. Cmnd 7664. HMSO, 1949 (March)
26. Factories Act 1961. HMSO
27. Offices, Shops and Railway Premises Act 1963. HMSO
28. **Council for Codes of Practice for Buildings:** British Standard Code of Practice CP 3 Chapter VIII (1949), Heating and thermal insulation. (The British Standards Institution), 1949
29. **Council for Codes of Practice for Buildings:** British Standard Code of Practice CP 3 Chapter I (C) (1950) Ventilation. (The British Standards Institution), 1950
30. **Institution of Heating and Ventilating Engineers:** op cit (23)
31. **Institute of Directors:** Better Offices (The Institute), ?1960
32. **Imperial Chemical Industries Limited:** Standards for offices and laboratories. (The Company), 1960
33. **Society of Civil Servants:** Office accommodation and allied subjects (The Society), 1963 (January)
34. **Black, Flora W:** op cit (3)
35. **Bedford, T:** Basic principles of ventilation and heating. H. K. Lewis. 2nd edition, 1964
36. **Heating and Ventilation (Reconstruction) Committee of the Building Research Board of the Department of Scientific and Industrial Research:** Heating and ventilation of dwellings. Post-war building studies no. 19. HMSO, 1945
37. Billington, reviewing work of Munro and Chrenko. See **Billington, N. S:** Comfort at work. J Inst Heat Vent Engrs. 1953, **21** (215) 141-4; **Munro, A. F.** and **Chrenko, F. A:** Effect of radiation from surroundings on subjective impressions of freshness. J Hygiene, 1949, **47** (3) 288-96
38. **Page, J. K:** 1963. op cit (19)
39. **Bruce, W:** op cit (4)
40. **Houghten, F. C., Gutberlet, C.** and **Witkowski, E:** Draft temperatures and velocities in relation to skin temperature and feeling of warmth. Trans ASHVE 1938, 289
41. **Manning, Peter:** The design of roofs for single-storey general-purpose factories. University of Liverpool, Department of Building Science, 1962
42. See, for example: **Knight, J. C.** and **Knight, J. L:** The air-conditioning of multi-room buildings. J Inst Heat Vent Engrs. 1962 (April)
43. **Hickish, D. E:** Thermal sensations of workers in light industry in summer. J Hygiene, 1955 (March)

warmer conditions which exist in summer, and wear lighter clothing but, due to either higher external temperatures or a build-up of heat within buildings, comfort zones are sometimes exceeded. The situation in offices is made worse by rising environmental standards and increasing business mechanisation, for the output of heat from lighting installations and office machines is often an inconvenient addition to the summer thermal environment. The point is illustrated in a table published by Page.[44] This shows the make-up of the cooling load for a particular room situated in Lat 52°N which has an electrical load of 6 watts/sq.ft (say, 90 to 100 lm./sq.ft of illumination, and no business machines). The output of heat from the electric installation represents 44 percent of the total cooling load.

Thermal conditions within buildings in summer may require consideration of all the four main thermal parameters. Because relative humidity is an important consideration if people perspire, equivalent temperature (which takes no account of this parameter) is usually considered unsuitable for assessing summer thermal environments. As yet no single comfort index is entirely satisfactory for defining the summer thermal environment. Conditions are sometimes specified in terms of separate values for the different parameters, but a number of recommendations have been made in terms of corrected effective temperature (CET). Page,[45] following others, has discussed some of the defects of CET, the most important of which are an exaggeration of the effects of humidity at temperatures below 75°F and the underrating of the effects of air movement at higher effective temperatures with high humidities.

A standard for optimum conditions of CET for light industrial workers in summer in England has been given by Hickish as 64.4°F with an upper limit of 71.0°F.[46] These recommended temperatures are low and during hot weather could hardly be obtained in the typical office which is not airconditioned.

The currently accepted basis for design for continuously occupied airconditioned buildings in the United Kingdom[47] is an internal dry-bulb temperature of 70°F and relative humidity not exceeding 50 to 55 percent, subject to the difference between the inside and outside temperatures not exceeding 10 deg F. This condition is necessary because a person entering a cool airconditioned space from a hot outdoor environment with sweat on his skin and in his clothing can experience a sudden chilling of his body. Direct solar radiation may increase the CET within a room very considerably. For example, some work reported by the Knights[49] of measurements made during April 1961 in an unheated London office building in which no lights were burning has shown some substantial differences between the temperatures inside the south-west and north-east corners. Although the air temperatures were the same (between 71 and 74°F on four different days) in both corners, when the blinds were not used the globe temperatures were 23 deg F higher than the air temperature in the south-west but only 2 deg F higher in the north-east. Similarly, CET was 14 deg F higher than air temperature in the south-west but only 2 deg F higher in the north-east. Use of venetian blinds reduced these differences: when the slats were fully closed the globe temperature was only 5 deg F higher and CET only 4 deg F higher than the air temperature in the worst case of the south-west corner.

Engineering design considerations

The method of heating used in an office building is likely to be a choice between mainly convective systems (eg, hot water radiators, forced-air convectors) or mainly radiant systems. Under-floor heating produces the most favourable vertical temperature gradients, but the practical problem is to provide sufficient heat within the room without creating uncomfortably hot floor surfaces. The extreme upper acceptable limit of floor surface temperature is considered[49] to be 80°F and it is usually recommended that temperatures lower than these (a maximum, say, of 75 to 77°F) should be sought. A more usual method of radiant heating in offices is to mount the radiating surface within the ceiling and it must then be ensured that the surface temperatures and mounting heights are such that they do not cause uncomfortably warm conditions at the head. Chrenko discussed some studies of subjective reaction to heated ceilings and provided a table of maximum desirable temperatures in relation to size of panel and height of ceiling.[50] Heating systems need to be zoned to allow for variations in orientation, height within the building and local conditions – for example, differences in density of people and heat-producing equipment.

The design of the thermal environment has to cope with

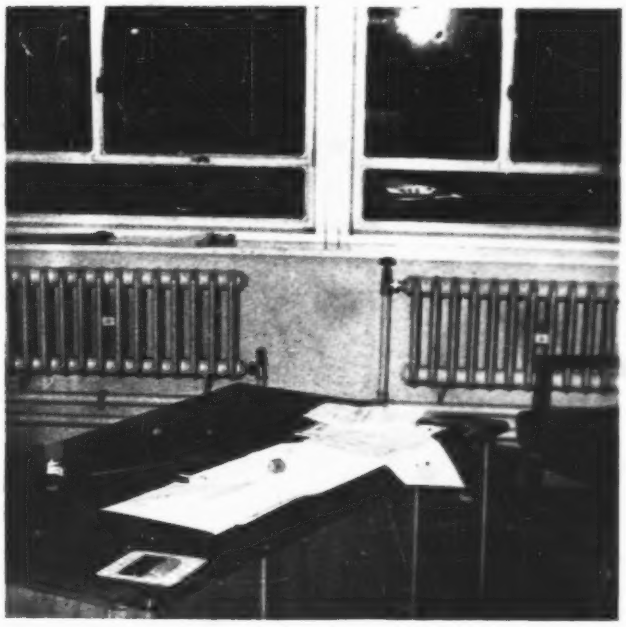

Figure 56
The most common form of heating is by hot water radiators mounted beneath windows.

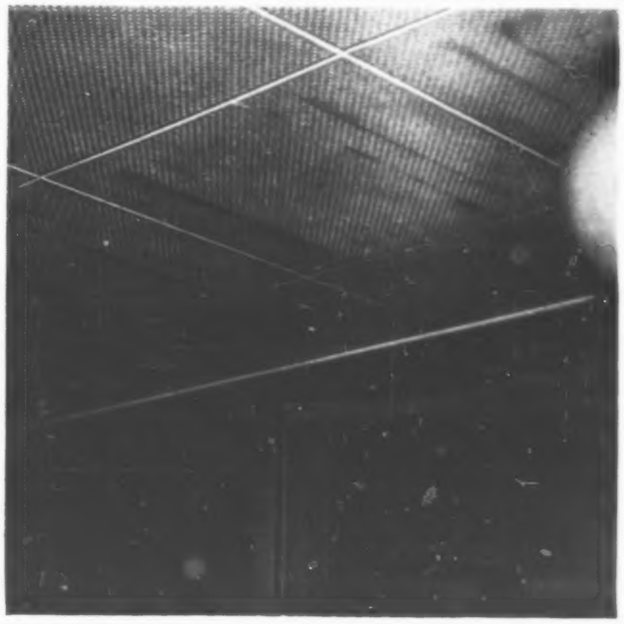

Figure 57
Radiant panel heating marking ceiling.

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[44] **Page, J. K:** Lighting and environment. Architects' Journal, 1962 (June 20)
[45] **Page, J. K:** 1963 op cit (19)
[46] **Hickish, D. E:** op cit (43). Recommendation attributed to Bedford. The standard used was that at least 80 percent of people should be thermally comfortable
[47] **Institution of Heating and Ventilating Engineers:** op cit (23)
[48] **Knight, J. C.** and **Knight, J. L:** op cit (42)
[49] See, for example: **Bedford, T:** 1964, op cit (35)
[50] **Chrenko, F. A.** op cit (22)

the conflicting requirements of different seasons. For example, the object of winter ventilation is to admit sufficient air to maintain a fresh atmosphere without causing draughts at working level. In summer it is necessary to provide air movement at working level and high rates of air change.[51]

Natural ventilation is dependent on weather conditions and is therefore highly variable. A design method which takes into account either stack or wind effects has been developed by the Building Research Station[52] but it assumes that the inlets and outlets are measurable and, in any case, is likely to be suitable only for shallow buildings. The core of a deep building will be exceedingly difficult, if not impossible, to ventilate by only 'natural' means.

If windows are to provide ventilation, then there is a conflict between the ways in which they fulfil their rôle in winter and summer. For winter ventilation high level openings and small apertures are to be preferred,[53] while in summer low level openings, cross ventilation, and high rates of air movement may be necessary to maintain comfortable conditions. In high buildings there are substantial problems of wind pressure and air infiltration through the cracks around opening lights.

A mechanical ventilating system has many obvious advantages but, because of numerous secondary effects on other parts of the building, it is difficult to ascertain its true extra cost. Including extra space for equipment and ducting, it might be of the order of 7 to 15 percent of the total building cost.[54] Although its use is still exceptional there is a growing tendency for airconditioning to be used, especially in tall buildings, because of wind problems, noise, air pollution, solar radiation heat gains, and the increasing output of heat from office equipment and electric lighting. The interiors of many deep-planned office blocks are likely to require all-year-round cooling. Figures provided by the Knights[55] suggest that the capital costs of a complete airconditioning installation used the whole year round might be 20 percent of total building costs (including furnishing) or 3 times as much as a conventional heating system.

Measurements of thermal conditions in offices

During this investigation measurements of the thermal environment have been made within office buildings with the object of learning how closely typical types of office building design conform to the recommended standards. The following is a summary of the main findings.[56]

Measurements of *winter thermal conditions* were made in six buildings, mostly during the period January to March 1963 when external dry-bulb temperatures varied around freezing point. In spite of the extremely cold conditions, the interiors of all the offices were warm and, in general, comfortable. There were, however, a number of complaints of draughts. Air temperatures in all six buildings never fell below 66°F, and the temperature of the surrounding surfaces and furniture[57] did not differ very much from air temperatures. Nearly all measurements of equivalent temperature fell within the comfort range of 66 and 72°F,[58] the mean value being 70.2°F.

Air temperatures in all the offices tended to increase from floor to ceiling but in no case was the difference between the floor and a level 6 ft above greater than 5 deg F.

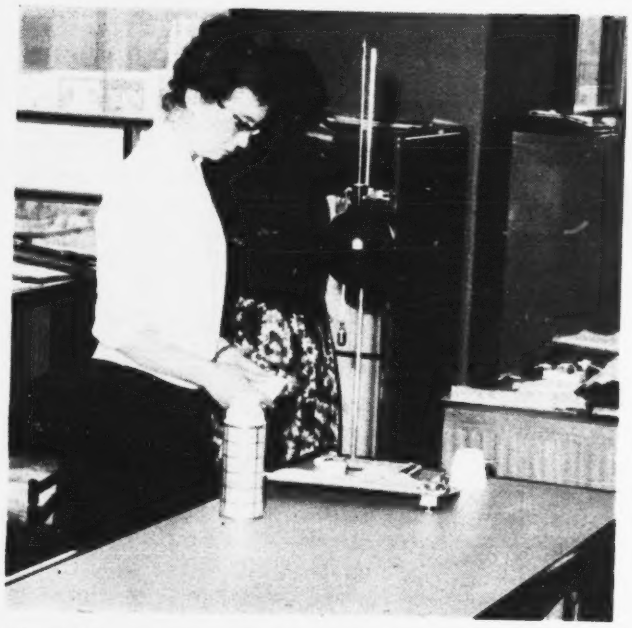

Figure 58
Simple measurements of the thermal environment.

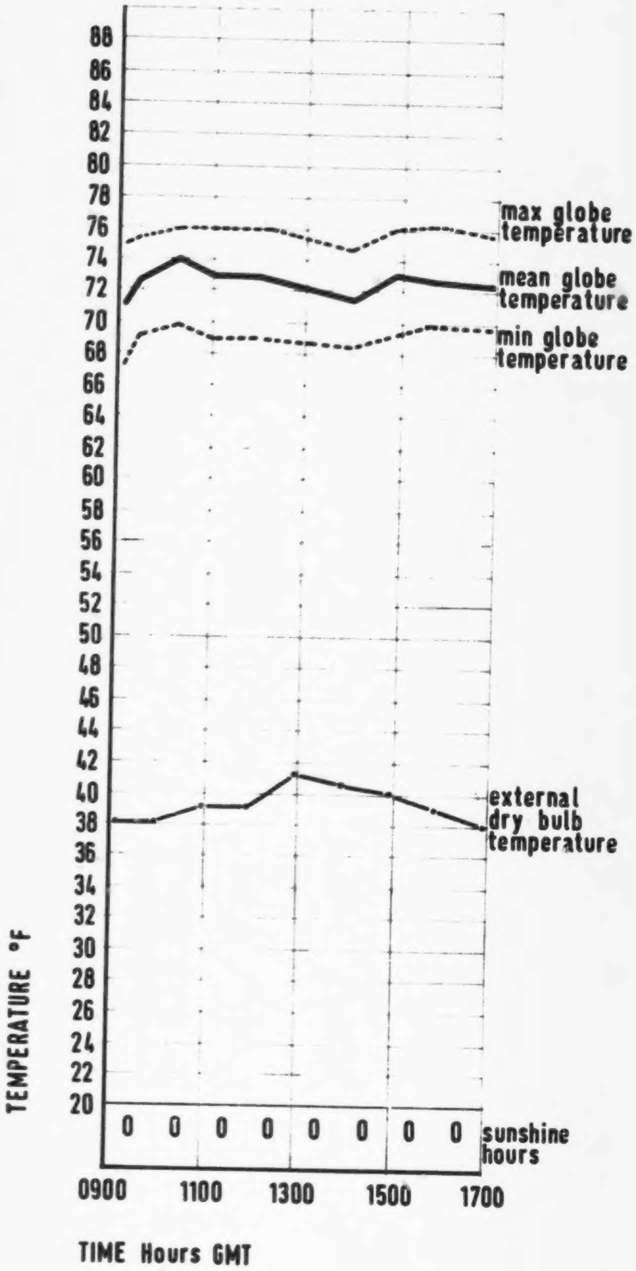

Figure 59
Thermal conditions on 7 February 1963 in an office building which is heated by ceiling panels and naturally ventilated.

Time (GMT)	1110	1510
Mean air temperature (°F)	72	72
Mean relative humidity (per cent)	34	35
Mean air movement (ft./min.)	25	51
Average EqT (°F)	70.6	70.7

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51. See: **Page, J. K:** Fundamentals of ventilation design. Architects' Journal, 1963 (July 3)
52. **Building Research Station:** The principles of natural ventilation of buildings. BRS digest no. 34. HMSO, 1951 (September)
53. Although the one building in which thermal measurements were made during winter which had this pattern of windows did not appear to be very satisfactory in this respect
54. **Imperial Chemical Industries Limited:** op cit (32)
55. **Knight, J. C. and Knight, J. L:** op cit (42)
56. See appendices 7.1 and 7.2 for description of survey methods
57. As indicated by globe temperature measurements
58. **Billington, N. S:** op cit (37)

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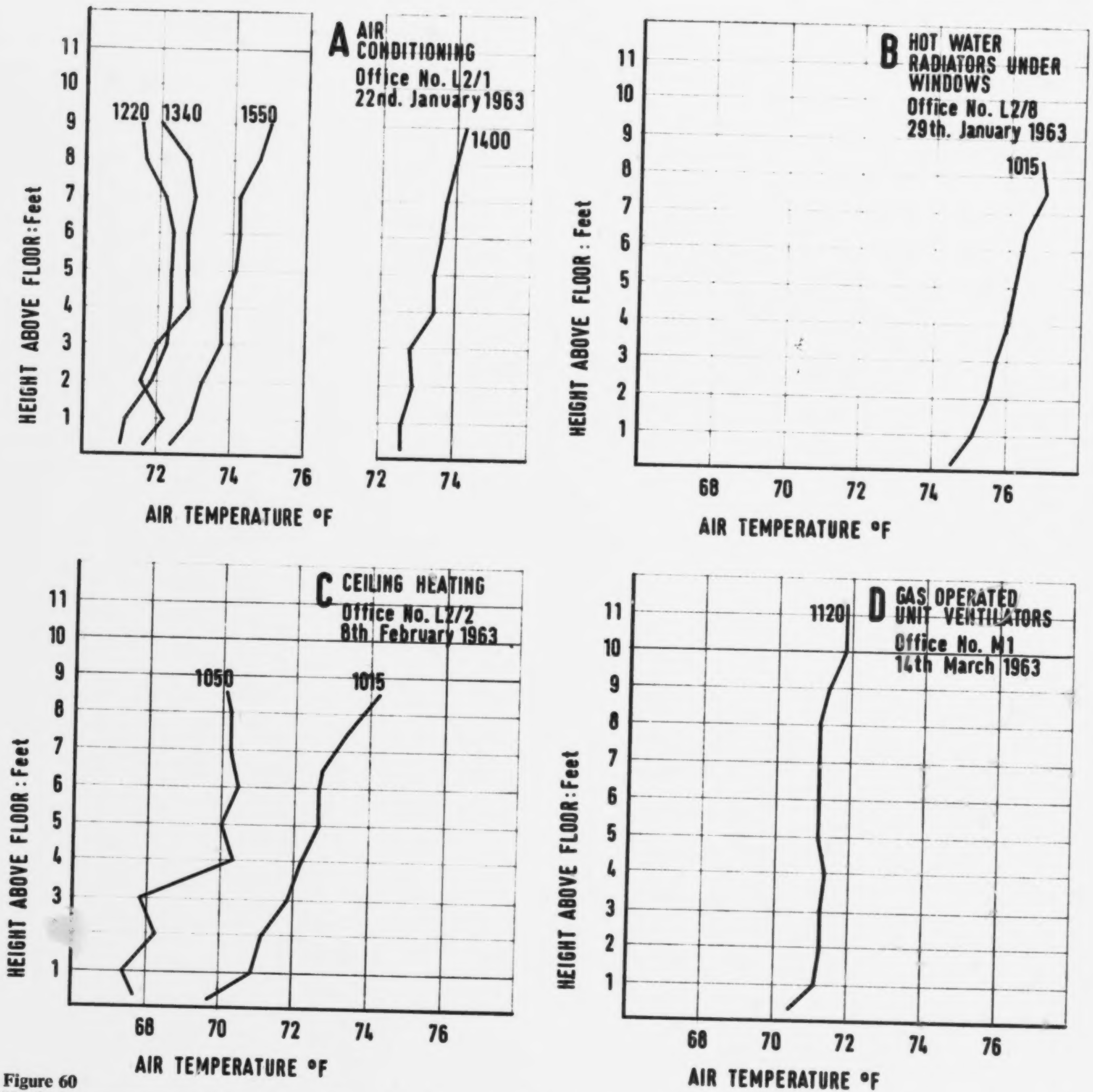

Figure 60
Vertical temperature variations in four offices with different types of heating installation.
In graph A, the group of curves at the left hand side shows temperature variations at a position 1 ft. from the window wall at different times. The right hand curve shows temperature variations at a position 20 ft. distant from the nearest windows.
In graph C the left hand curve shows temperature variations 6 inches from the external wall. The distinct change of shape in the curve is attributable to down-draught from and/or air infiltration through the windows.
All other curves are representative of conditions within the occupied areas.

The largest gradients occurred in a building which has a ceiling panel radiator system. Horizontal 'gradients' were generally level, though, as was to be expected, the interiors of deep buildings tended to be warmer than the perimeter. Because of the cold weather, windows were rarely opened during the period of the surveys and, probably as a consequence, air speeds were low, being mostly between 15 and 30 ft/min. The experimenter felt that some of the offices were stuffy and in one of them body odours were evident. Airconditioned offices maintained optimum levels of relative humidity whereas all the offices which relied upon natural ventilation had mean values between approximately 30 and 40 percent; a few individual values dropped to 27 percent.

Systematic studies of staff response to the thermal environment were made in one building, over a period of time, by means of interviews and questionnaires. In the early stages of the investigation the building had only recently been occupied, the airconditioning system had not been adjusted to its working trim and varying temperatures and draughts were causing widespread discomfort. When the installation had been brought under control, the temperature was generally regarded as comfortably warm (sometimes, too warm and slightly stuffy); experience of draughts diminished.[59]

Measurements of *summer thermal conditions* were made when it was forecast that the weather would be warm and sunny, with shade air temperatures reaching over 70°F. Unfortunately there were only two such periods in the summer of 1963, the first at the beginning of June, the second at the end of July. During these times it was possible to survey only three buildings, two naturally ventilated and one airconditioned.

In the airconditioned building the majority of CET's were between 68 and 70°F (ie, within the comfort zones mentioned earlier); the maximum being 73.5°F. In one of the naturally ventilated buildings, at positions not in direct sunlight, the CET was mainly between 71°F and 75°F with a minimum of 68°F so that, for much of the working day, the comfort zone was exceeded. In the other naturally ventilated building the CET was also high, being mainly between 70°F and 72°F.

One of the important factors governing the summer thermal environment is the amount of direct solar radiation penetrating the building. The amount transmitted by bare unshielded glass depends on its thickness and colour and on the angle at which the radiation strikes

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[59] See chapter 10

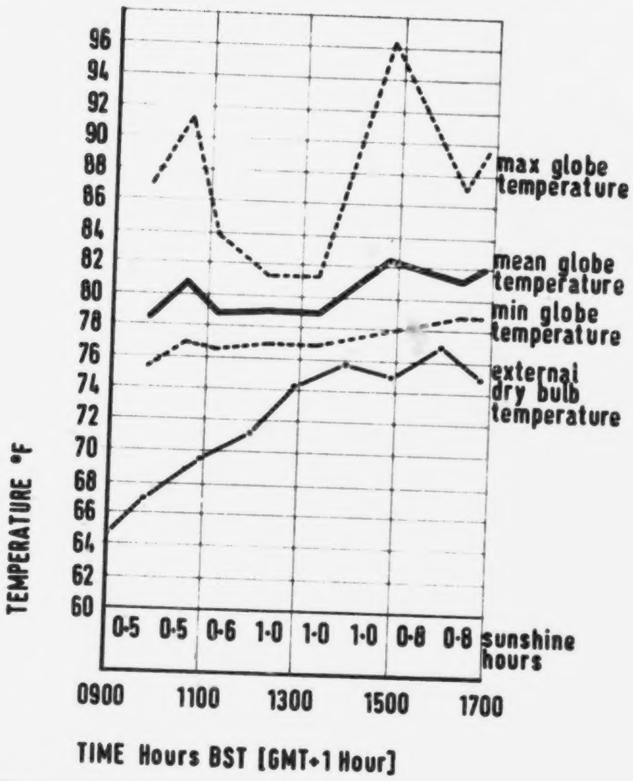

Figure 61
Thermal conditions on 31 July 1963 in a naturally ventilated office
The peaks on the curve for maximum globe temperature were due to sun shining directly on some of the globes.

Time (BST)	1110	1600
Mean air temperature (°F)	76	79
Mean relative humidity (per cent)	45	35
Mean air movement (ft./min.)	—	25
Average CET (°F)	—	72.5

it; the transmittance of solar heat energy through typical clear glass at normal angle of incidence is about 80 per cent–ie, substantial. The effect of venetian blinds has already been referred to;[60] 'shade factors' for various other types of shading equipment are given in the ASHRAE Guide.[61] In the airconditioned building the vertical white 'venetian' blinds, when used, seemed to be effective in preventing high radiant temperatures. The management of another office was experimenting with several types of blind and trying to decide which was the most effective. The third building has thick grey curtains but it was not possible to take sufficient measurements to assess their effectiveness as a form of solar heating control.

The staff in the airconditioned office had been instructed to draw the blinds on the south-eastern side of the building at the end of the working day so that heat gains in the early morning should be minimised. Apart from this one instance, office staff in other buildings in the Survey Sample did not anticipate solar heat gains and blinds were never drawn until the sun had been shining for some hours.

Although the surveys were made on some of the hottest days of the year, conditions never became so severe that people were not able to carry on with their normal work, and they were well below the limiting (ie, extreme) CET's of 90.1 to 92.2°F quoted from F. E. Smith[62] by Page[63] which are appropriate to 'sedentary work'.

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[60] **Knight, J. C.** and **Knight, J. L:** op cit (42) and (48)
[61] **American Society of Heating, Refrigerating and Air-conditioning Engineers:** op cit (2)
[62] **Smith, F. E:** Indices of heat stress. Medical Research Council, memorandum no. 29. HMSO, 1955
[63] **Page, J. K:** 1963 (June 19) op cit (19)

Chapter 8
The aural environment

With the increase of traffic in towns and cities, the use of lightweight construction and larger windows in office buildings, and the growing use of office machinery, noise in offices is becoming an ever increasing problem. Noise is commonly believed to affect health, although this has not yet been confirmed by experimental research. The Wilson Report[1] says that if the World Health Organisation's definition of health ('. . . a state of complete physical, mental and social well-being, and not merely an absence of disease and infirmity') is adopted, then, since people's well-being is diminished by noise, noise affects health. But, as the report later shows, in the more narrow (and usual) meaning of the word, there is no evidence that the noise levels customarily 'met with domestically and socially' (say, within offices) produce any 'direct and measureable physiological' effect upon the average person. No reliable studies of the effects of noise on normal mental health were known to the Committee. Noise, whether continuous or intermittent, above 'about 90 dB' has been shown to cause a significant increase in the number of errors made; it has not been possible to isolate any harmful effect of noise alone below this level.[2] Despite the absence of proof, most office staff, especially those doing non-routine work requiring concentration, are convinced that a noisy environment results in their work being less efficiently performed than it might otherwise be. Part of the reduced efficiency may result from the repetition of effort involved in catching up with an interrupted train of thought.[3]

Previous surveys of the aural environment in offices

There have been few studies of acoustic conditions in offices in Britain.

The civil service study group[4] reported that (twenty or so years ago) complaints about noise were frequent. It found that six of the seven commercial buildings in noisy locations which it visited were equipped, in noisy parts of the buildings, with either double windows and mechanical ventilation or mechanical ventilation alone (so that windows could be kept shut). Although a majority of the government offices which the group inspected had at least one noisy side no special precautions against noise were seen except a few cases of double windows in very important rooms.

The Liverpool reports made no mention of noise except to remark[5] that, in the centre of urban areas, windows cannot remain open because of street noises and fumes. In nineteen of the 50 offices in the Barrow survey[6] noise was said to be disturbing. The investigators thought it '. . . true to say that the amount of natural ventilation was governed by the amount of noise.' External noise interfered with conversation in 19 percent of the offices in the City of London survey[7] and internal noise did the same in another 12 percent. 3 percent of offices had double windows. Noise was one of the least satisfactory aspects of the mechanical offices. 'In machine rooms noise levels at working positions usually exceeded 94 phons (83 dB)'.[8] There was some relation between the type of work performed and the level of noise found tolerable: machine operators accepted higher levels of noise than punch operators who in turn accepted higher levels than clerical workers.

The Building Research Station's survey of post-war London offices[9] is reported to have shown that large numbers of the occupants are disturbed by street noise – 45 percent overall, and 65 percent in buildings on main streets. Internal noise is less of a general problem and mainly occurs in large clerical areas and typing and machine rooms. Within the offices the noise climate, from all causes, including street noises, movement of chairs, closing of filing cabinets, etc, is often in the range 60 to 77 dBA, rising to 80 to 95 dBA.

It has been stated in a BRS Digest[10] that, apart from noise at first and second floor levels being slightly less than at ground level, traffic noise is not greatly influenced by height above ground. The Wilson Report[11] mentioned some studies by the London County Council which seem to confirm this statement and referred to the BRS/COI survey of post war offices which may be the source of the statement. It is believed that the effect occurs not only in street 'canyons': it can also be found with comparatively isolated tall blocks where the sides and rear of the upper storeys are not screened, as they are nearer ground level, from noise generated in distant streets.

Legislation

The recent Act[12] has provisions enabling special regulations to be made to safeguard the health and welfare of employees from noise or vibrations. No such regulations have been made yet.[13]

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[1] **Committee on the Problem of Noise:** Noise: final report. Cmnd 2056. HMSO, 1963 (July)

[2] **Committee on the Problem of Noise:** op cit (1)

[3] **Bagenal, H:** Noise. Paper in: Office buildings: report of a symposium held on 12th April 1956 at the Royal Institute of British Architects. (The Institute), 1956

[4] **Study Group appointed by HM Treasury:** Working conditions in the Civil Service. HMSO, 1947

[5] **Wattleworth, W. H:** The forgotten army. Royal Society of Health Journal, 1959 (March-April)

[6] **Nelson, I. D. M.** and **Morse, R. J:** A pilot study of office accommodation. The Medical Officer, 1960 (September 9)

[7] **Robinson, Alan:** Working in the city: the interim report of a survey. City of London Health Department, 1962 (December)

[8] **Langdon, F. J:** The design of mechanised offices. Architects' Journal, 1963 (May 1)

[9] Reported, so far, only in: **Langdon, F. J.** and **Keighley, E. C:** User research in office design. Architects' Journal, 1964 (February 5)

[10] **Building Research Station:** Noise and buildings. BRS digest no. 38 (second series). 1963 (September)

[11] **Committee on the Problem of Noise:** op cit (1)

[12] Offices, Shops and Railway Premises Act, 1963. HMSO

The nature of the acoustical problem

There are two main acoustical problems in offices:

(i) of reducing noise which may irritate or distract staff or interfere with direct or telephone conversations

(ii) of securing privacy where this may be needed.

These problems require consideration of both sound absorption (ie, reduction of reflection and hence reverberation time) and sound insulation.

Noise experienced within an office originates both outside and inside the building. The relative importance of these two origins differs from office to office but, especially in buildings located in busy city centres, street noise is often the major problem.

There is little that can be done to restrict external noise in existing buildings and, given a noisy central location, not much more for new buildings, especially those with light external cladding, although specially detailed fixed windows and mechanical ventilation may help a little. A suggestion has been made[14] that where external noise is likely to be a critical factor in the acceptability of the environment of a proposed new office building, a noise level survey should be conducted on the site before design is commenced and the actual range of exposure established. This information could then be used to influence decisions about the total area of windows and their detailed design.

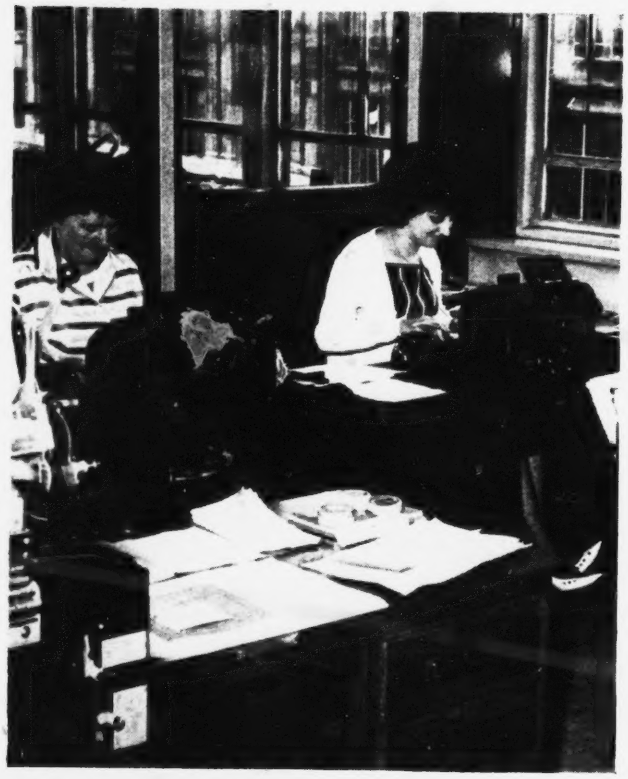

Figure 62
A machine section separated from general clerical areas.

Noises within office buildings are likely to originate from several sources, including:

(i) office machinery (eg, typewriters and calculators)

(ii) telephone conversations and other voiced sounds

(iii) footsteps and slamming of doors originating within offices, outside in corridors, and overhead

(iv) ventilation plant and lift machinery

(v) internal constructional and office-fitting work

and will be of two types, air-borne and structure-borne.

The problem of securing privacy in offices is fundamental to the design of the building for, without interfering with ambient noise levels, the only effective way is through massive construction. In other words, it is preferable that the office spaces where privacy is important should be selected in the early stages of design, and their location and/or construction decided expressly to achieve the required sound insulating characteristics. These characteristics are virtually impossible to obtain if demountable, lightweight partitions are used. A different approach has been attempted in the United States where it is reported that built-in masking noises have been used in 'several important office buildings' to ensure adequate speech privacy between offices separated by such partitioning.[15]

Figure 63
Noise source: telephones.

Figure 64
Noise source: desk calculators.

Noise criteria for offices

Because the 'sound pressure level' (SPL) given by a sound level meter does not give an adequate measure of the subjective effects of sounds, quantities which indicate this have been developed. They include:

Loudness level (LL) in phons

Speech interference level (SIL) in decibels.

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13. September 1964

14. **Miller, Laymon N**: Case histories of noise control in office buildings and homes. Chapter 22 in: Noise reduction (Ed: **Beranek, L. L.**) New York, McGraw-Hill. 1960

15. **Watters, B. G**: Speech-privacy considerations. Appendix C to Chapter 20 in: Noise reduction (Ed: **Beranek, L. L.**), op cit (14)

The loudness level of a sound is defined as the sound pressure level of a 1,000 c/s tone that sounds equal in loudness to the sound being rated. It can be calculated from the octave-band levels by a method due to Stevens.[16]

The speech interference level is an approximate guide to the interfering effect of noise on speech. It consists of the arithmetic mean of the octave-band pressure levels in three bands: 600 to 1,200; 1,200 to 2,400 and 2,400 to 4,800 c/s and ignores the contribution of the lower and higher frequencies.

A SIL of 45 to 60 dB is considered 'slightly difficult' for telephone use;[17] a SIL of 50 to 55 dB is considered acceptable for secretarial, clerical or typing rooms.[18]

An extension of these units has been made by Beranek[19, 20] who found from a series of studies of noise in offices that the subjective ratings of the occupants correlated well with both the speech interference levels and loudness levels when there was a difference of 22 units between the LL (in phons) and the SIL (in decibels). He derived a series of noise criterion (NC) curves from which the permissible sound pressure level in eight octave bands can be read.

The loudness level for each curve is 22 units greater than the speech interference level, the SIL in decibels being given by the NC number of the curve. NC values considered suitable for certain office situations in Britain, based on a table of recommended noise criteria for offices by Beranek, are given in table **7**. The values are applicable to offices in normal operation but with nobody speaking at the particular desk or conference table which forms the focus of the situation.

Table 7
Recommended noise criteria for offices

Situation	Recommended maximum NC value
Board rooms, conference rooms, private offices for use of one person	30 to 35
Offices occupied by between two and ten people	35 to 40
General offices, occupied by more than ten people	40 to 50
Offices in which business machines, including typewriters, are the main source of noise	50 to 55

Based on Beranek's recommended noise criteria for offices. See: **Beranek, L. L:** Revised criteria for noise in buildings. Noise Control, 1957 3 19-27.

The A-weighting network on sound level meters is often used to specify particular noise levels. This is a single value approximating to the sound heard by the human ear, which is used without reference to the sound pressure levels in particular frequencies.

Beranek has pointed out[21] that the same A-scale reading may be obtained for a wide variety of shapes of noise spectra. Moreover, the values of the eight octave bands are necessary for the engineering design of noise control measures, so a single number cannot be adequate. However, it has been shown recently[22] that noisiness as rated by 'executive office personnel' can be correlated with 'A' sound levels. The Wilson Committee's recommendations[23] were given in dBA, and the BRS's recent London Noise Survey[24] has also used these units. A simple method of converting readings of dBA on the sound-level meter into 'Stevens phons'[25] has been given by Parkin and Humphreys:[26] the dBA reading is multiplied by 1.05 and 10 is added.

There are a number of other noise ratings in use but the ones used in this report are dBA and Noise Criteria, for these are the two most commonly used in connection with buildings.

Recommended standards

The following standards have been advocated by different authorities:

Noise level within an office	an upper limit of 55 dBA[27] based on SIL
Partitions: insulation	
Where at least one room has a need for quiet or privacy	a minimum of 45 dB[28]
Clerical offices where noise is not a major nuisance	a minimum of 20 to 30 dB[29]
Floors: insulation	
Insulation (airborne) for floors plus, preferably, a resilient finish	a minimum of 45 dB[30]
Reduction of impact sound on floors by provision of resilient finish	a minimum of 10 phons[31]
Reverberation time (empty rooms)	
Small private-office	0.75 seconds[32]

Figure 65
In this building typing pools are small and the rooms have large areas of sound absorbent materials, including carpeted floors.

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[16] **Stevens, S. S:** Calculation of the loudness of a complex noise. J Acoust Soc Am. 1956, **28** 807-832

[17] **Council for Codes of Practice; British Standards Institution:** British Standard Code of Practice CP 3 Chapter III (1960). Sound insulation and noise reduction. (The Institution), 1960

[18] **Anon:** Noise. Chapter 2 in: Better offices. Institute of Directors, ? 1960

[19] **Beranek, L. L:** Criteria for office quieting based on questionnaire rating studies. J Acoust Soc Am. 1956, **28** (5) 833-852

[20] **Beranek, L. L:** Revised criteria for noise in buildings. Noise Control, 1957, **3** 19-27

[21] **Beranek, L. L:** Criteria for noise and vibration in buildings and vehicles. Chapter 20 in: Noise reduction (Ed: **Beranek, L. L.**), op cit (14)

[22] **Young, Robert W:** Single-number criteria for room noise. J Acoust Soc Am. 1964 (February)

[23] **Committee on the Problem of Noise:** op cit (1)

[24] See, for example: **Purkis, H. J:** Transport noise and town planning. Journal of Sound and Vibration. 1964, **3** 323-34

[25] **Stevens, S. S:** op cit (16)

[26] **Parkin, P. H.** and **Humphreys, H. R:** Acoustics, noise and buildings. Faber (second edition), 1963

[27] **Committee on the Problem of Noise:** op cit (1)

[28] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[29] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[30] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[31] **Acoustics Committee of the Building Research Board of the Department of Scientific and Industrial Research:** Sound insulation and acoustics. Post-war building studies no. 14. HMSO, 1955

[32] **Council for Codes of Practice; British Standards Institution:** op cit (17)

General office Office-machine room Typing pool	1.0 second (may be increased to 1.25 seconds for 'very large offices')[33]

The Code of Practice[34] contains a recommendation that, in the interests of noise reduction, typing pools should be restricted to about twelve machines to a room.

One industrial firm has adopted standards[35] based upon the distance over which a conversation should be possible when normal speaking voices are used:

Private offices: audible distance of	10 ft (equivalent[36] to SIL of 45 dB)
General office: audible distance of	5 ft (equivalent to SIL of 51 dB)
Machine rooms: audible distance of	3 ft (equivalent to SIL of 55 dB)

Constructional considerations

External walls which are of heavy construction tend to minimise the transmission of sound (eg, of street noises) but windows constitute a weak link, for they allow the passage of noise more readily than most wall constructions. Compare, for example, the insulating value of a 9 inch brick wall (50 dB) and a closed 'openable' single window (18 to 20 dB).[37] In order to maintain a tolerable level of noise within rooms in heavily trafficked areas it may be necessary to use fixed double windows and mechanical ventilation.

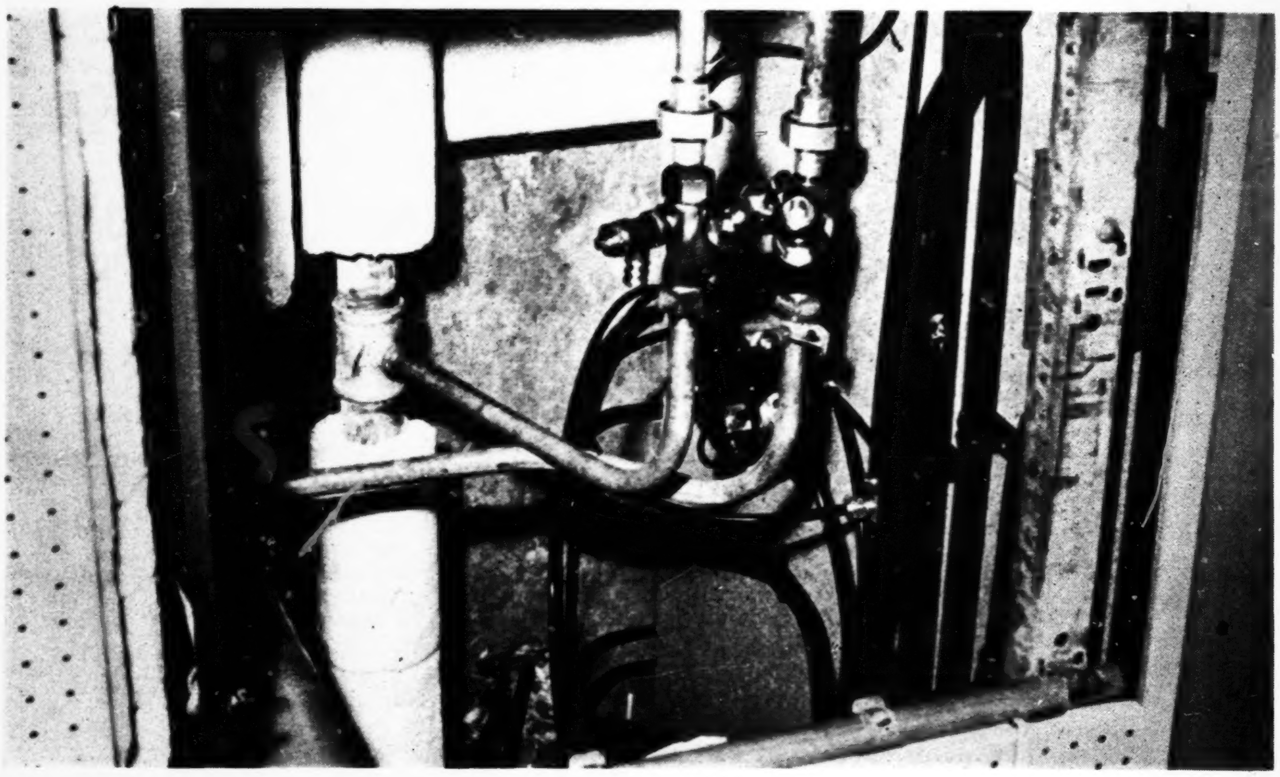

Figure 66
The space above a suspended ceiling is difficult to soundproof.

The minimum effective spacing of the two panes is about 4 inches but greater widths are preferable, especially for low and middle frequency sounds[38] (eg, city centre traffic). Sound reduction is increased by providing an absorbent lining to the cavity and it is advisable to separate the frames of the two panes. Curtain walling, because it consists of lightweight members which are dry-jointed, provides greater opportunities than traditional systems of cladding for external noise to penetrate to the interior.[39, 40]

The choice of materials for internal walls and partitions includes solid walling (eg, in-situ concrete or brick or block), framed walls constructed in-situ (such as timber framing with glazed or boarded panels) and proprietary demountable systems of partitioning. The sound reduction value of a 4 inch brick wall plastered both sides is about 45 dB;[41] a very high standard for a demountable partition (which would be an expensive component) is only about 35 dB.[42] In rooms which have suspended ceilings the detailing of the connection between partition and ceiling is critical for the ceiling void provides a simple route for the passage of sound from one side to the other. This space is very difficult to soundproof effectively, especially if it contains piped services or other irregular obstructions.

The choice of floor finish offers an opportunity for reducing one of the causes of internally created noise – ie, footsteps – at its source. A resilient finish to absorb the energy from footsteps is especially needed in open-plan offices. The ceiling can be used to reduce, by absorption, the general level of noise.

Surveys of noise within offices

During this study measurements of noise have been made in a number of offices within a total of nine buildings, the object being to make comparisons of typical conditions with recommended criteria. Measurements were made during working days but not at rush hours[43] so the results should be reasonably indicative of general conditions. They show that the noise levels in most clerical offices were well up to, and usually exceeded, the Wilson Report's upper limit of toleration of 55 dBA in buildings in which 'speech is of great importance'.[44] In business machine rooms, noises were usually of the order of 70 to 75 dBA. The recommended NC values were ex-

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[33] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[34] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[35] **Imperial Chemical Industries Limited:** Standards for offices and laboratories. (The Company), 1960 (April)

[36] On basis of table 6: maximum speech interference levels, in: **Council for Codes of Practice; British Standards Institution:** op cit (17)

[37] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[38] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[39] **Committee on the Problem of Noise:** op cit (1)

[40] **Markus, T. A:** The glass curtain wall: Fire resistance and sound transmission. Architects' Journal, 1957 (December 12)

[41] **Council for Codes of Practice; British Standards Institution:** op cit (17)

[42] **Burgess, Roger A:** Insulation of partitioning as a design factor. Architects' Journal, 1962 (January 31)

[43] See appendix 8.1 for details of methods used in noise surveys

[44] **Committee on the Problem of Noise:** op cit (1)

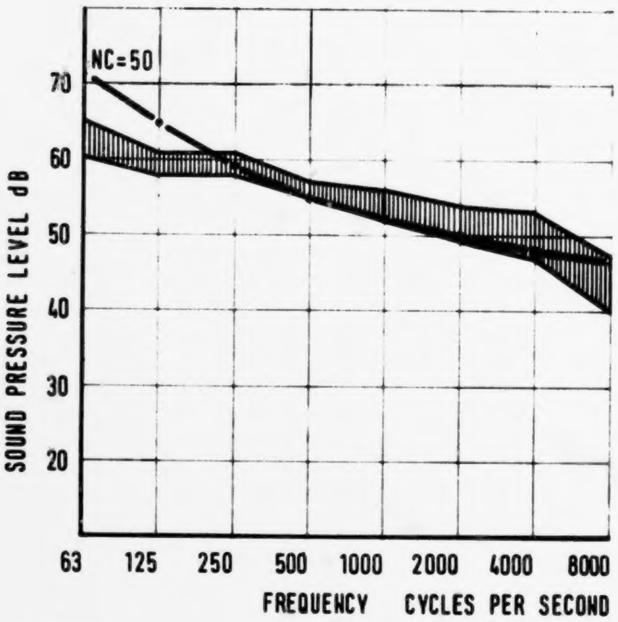

Figure 67
Noise spectrum in centre of large general office (about 500 staff in one undivided space). Cork floor, acoustic tile ceiling (59-61 dBA).

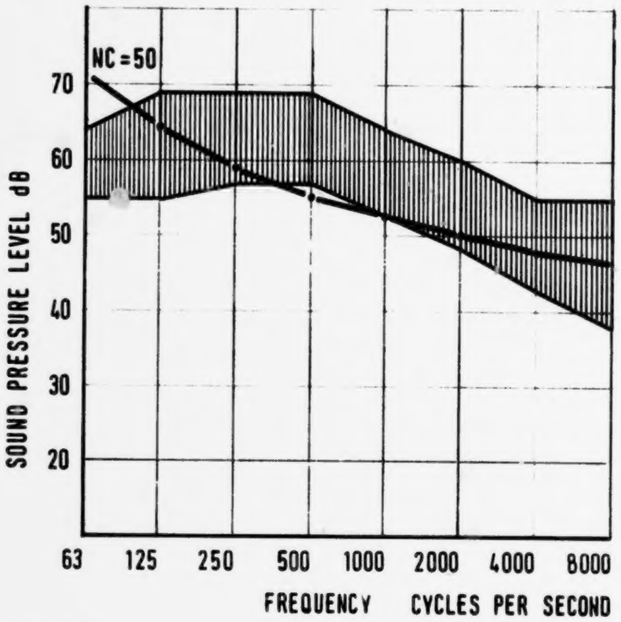

Figure 68
Noise spectrum in large general office (55 staff). Plastic tile floor, hard plaster walls and ceiling, metal furniture (58-67 dBA).

ceeded in some frequency bands in almost all of the offices visited. However, there is little point in achieving low NC levels in private offices if they are *not* private, and in some of the offices in which the recommended criteria had been achieved, noise and conversation in adjoining rooms could be heard. The spectra measured in general offices followed the NC curves better than the spectra measured in machine rooms, where the noise levels decreased little, if at all, at the high frequency end of the spectra.

Traffic was a major source of noise in the private offices and in many of the clerical offices too. The effect of opening windows was to raise NC values by approximately 5 to 10 units.

The staff in one large, fully airconditioned and open-planned building with fixed glazing bordering upon a busy main road were asked about the acoustic conditions. Two-thirds stated that their building was *not* distractingly noisy; what noise they heard was believed to originate inside the building from normal conversation, movement and office machinery. Yet the noise levels were, in fact, in the region of 50 to 55 dBA in clerical spaces, ie, at the Wilson maximum, and 70 to 75 dBA in machine rooms. The fact that the acoustic conditions

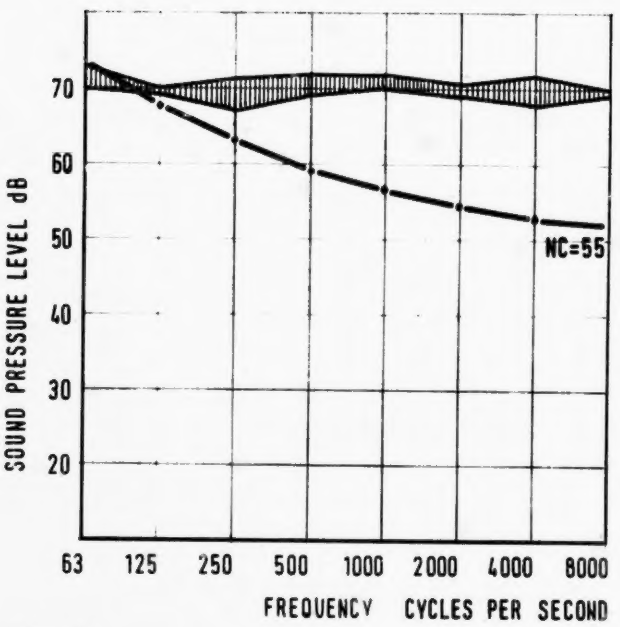

Figure 69
Noise spectrum in small machine room (4 operators). Plastic tile floor, hard plaster walls and ceiling. (75-80 dBA)

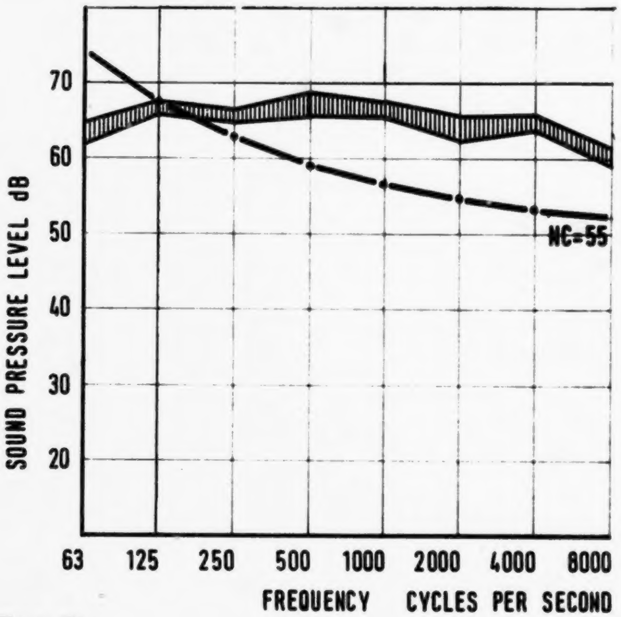

Figure 70
Noise spectrum in centre of large machine room (more than 100 operators). Floor, ceiling and three out of four walls surfaced with sound absorbent material (70-73 dBA).

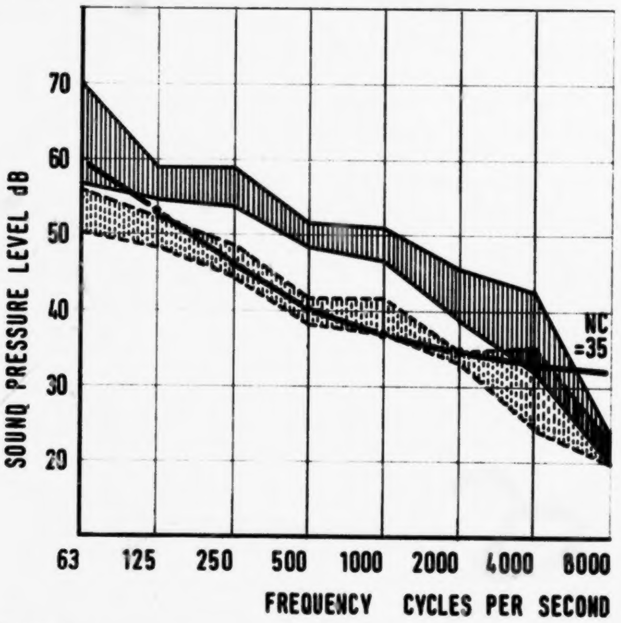

Figure 71
Noise spectra in empty private office. Spectrum shown in broken line represents noise levels with window closed (Window closed 45-47 dBA; open 52-56 dBA).

in this building were not worse must, in large measure, be due to the quality of the detailed design: acoustic ceiling, rubber floor, rubber tipped chair legs and fixed windows.

In another building, in one very large and completely open office space accommodating about 500 people, the experimenter felt that, although the measured noise levels were high (about 55 to 65 dBA), the general impression was one of surprising quiet; the occupants did not seem to have any difficulty in talking or using the telephone.

Chapter 9

Subjective and social aspects of the environment

In an article intended to introduce the subject of social psychology to architects, Noble wrote[1] '. . . as architects we help to shape people's future behaviour by the environment we create'. This belief is very widely held amongst architects and, if it is true, it is of concern not only to architects but also to behavioural scientists and the general public.

While an architect may be curious about the way this shaping of behaviour happens, his primary concern is with the building. His questions, therefore, can be expected to be framed in such terms as, 'In what ways should a desire for people's wellbeing influence the design of the building?' Any architect seeking the answers to questions such as this about an office building will be optimistic. For although, over the last few years, the Building Research Station has conducted a number of investigations involving psychologists and other behavioural scientists, the published literature on systematic and quantitative studies of qualitative aspects of architecture is negligible.[2]

At present, design decisions affecting the social environment of office buildings are made almost entirely on the basis of expectation or personal prejudice, rather than knowledge. For example, an architect may feel that layout must be based on small rooms, because people are more happy in small groups 'with which they can readily identify themselves'[3] than they are in large ones. Yet there seems to be no properly established bases for such a belief, nor for many other unquestioned attitudes which are the starting point of an architect's design process.

In the practice of his profession, especially perhaps in the design of workplaces, the architect suffers from two disadvantages. Firstly, his knowledge of user-requirements is often not first-hand. He may, for instance, have to deal with a client who has only a superficial knowledge of his rank and file clerical workers and their requirements. This situation is likely to be particularly true where the client is a developer, top-level executive, or, in the case of the civil service, from another ministry. The architect's second disadvantage is that he is rarely in a position to assess the success or failure of his building, except through the comments of his professional colleagues and the specific complaints of his clients. Page,[4] analysing some of the other communication problems of the building industry, used the description of 'a system of zero feedback', and this seems to be an appropriate summary of present practice in this context too, for it often happens that the architect's only connection with a building, once it has been occupied, is with particular decorative or constructional problems. The role of the architect, as understood by the client, does not appear to carry responsibility for the happiness and efficiency of the occupants (especially where the purpose of the building is not clearly 'social') and this may affect both the brief and the feedback. Failure to get a proper return of information about the effect of his building upon the users may mean that the architect's accumulated experience of practice counts for less than might be expected: his success in providing the best possible environment may not be much greater at the end of his career than it was at the outset. Clearly, this sort of practice is non-scientific, for science is cumulative and depends upon previous experience, each problem being tackled as one of a class about which a great deal is known in at least a general sense.

The notion of influencing and shaping behaviour through the building environment can be interpreted in many ways, but it is convenient to discuss it under the headings of health, efficiency, amenity, and personal and social effects.

Health

Health studies in commercial or industrial buildings tend to concentrate upon those features of the environment which present a hazard to the physical well-being of the workers, insofar as they have effects that are measurable in terms of affected health. The manner in which behaviour may be affected by environmental conditions in this instance is dictated by the resultant health conditions. For example, a number of behavioural consequences follow total or partial deafness caused by inadequate sound reduction, or respiratory problems caused by bad thermal conditions. These, however, are rather gross examples of the influence of the environment, and ones which are not likely to bulk large in a study of office environments where the statutory requirements are met.

Efficiency

The type of environmental study which has been most extensively pursued is into the nature of the optimum physical conditions at which a given group of people will operate most efficiently while performing a given range of tasks.

Strother has drawn attention to the evolution that has taken place in research into the working environment: 'The studies of the World War I era and the twenties centred primarily around an input-output approach to the human problems of industry. The human being was re-

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1. **Noble, J**: The how and why of behaviour: social psychology for the architect. Architects' Journal, 1963 (March 6)
2. Though publication of both the full report on the study of mechanised offices (? completed 1960) and the C O I study of post-war offices which was undertaken in 1961 must be imminent
3. See, for example, **Salmon, G**: Setting the scene. Chapter in: Better Offices. Institute of Directors, London (The Institute), ? 1960
4. **Page, J. K**: The building industry: a system of zero feedback. The Builder, 1962 (August 31)

garded largely as an isolated phenomenon affected by a variety of environmental conditions which could increase or decrease his output'.[5] He also referred to the historical importance of Elton Mayo's extensive study at the Hawthorne Works of the Western Electric Company.[6] Previous to the Hawthorne study it had frequently been observed that higher amenity levels of such environmental factors as illumination, ventilation and heating resulted in increased output and this was generally believed to be due to more favourable physiological stimuli resulting in more favourable physiological responses. This was thought to be true of those results of the Hawthorne experiment where higher output followed improved visual conditions, but it was also found that reduction of the illumination levels, in some cases to such a degree that the workers were hardly able to see well enough to work, still resulted in increased production. The interpretation drawn, and one which has been confirmed by much subsequent experimentation, was that workers responded more to the interest being shown in them as persons, as marked by the research, than to the prevailing physical conditions.

Mayo's research is the classic example demonstrating the inadequacy of environmental research which deals only with overt stimuli and responses. Strother summarised its influence by writing 'If the 1920's could be called the era of the human engineering approach, the 1930's marked the beginning of the human relations approach'.[7] This may be theoretically and academically true, but in fact the human engineering (or 'ergonomic') approach to environmental studies is still a vigorous reality, possibly because much applied research is financed by industrial companies which are more interested in the facts of increased efficiency than in their causes. The Hawthorne experiment showed that cause and effect do not necessarily need to be understood for the production of favourable effects. The exact way in which behaviour is influenced in such circumstances has still to be fully described; it is not yet in a form likely to be of any help to the architect in planning his building.

Amenity

Apart from studies of the behavioural consequences of environmental conditions, there has more recently been some formal research on subjective reaction to design features in the home and at work. Inherent in this type of research is the notion that if the conditions that people say they find most congenial can be provided, then the influence of the environment can be nothing but beneficial. This is the 'market research' type of approach which aims at establishing the most satisfying and pleasant working conditions, and regards these aims as being sufficient in themselves.

Everyday experience, however, provides a warning. In making judgements about conditions that he has not experienced, or which he has experienced for only a short time, the individual cannot be in a position to make a choice based on knowledge and reason. His judgement is not objective and takes as its reference point a limited subjective experience. The problem is made more complex when prejudice and attitudes, not specifically connected with the judgements being made, are superimposed. Both Jahoda[8] and Raven[9] have drawn attention to the prejudice that leads people to choose the conditions that they are used to rather than the ones that they are not.

The prejudice of preferring what has been experienced (rather than what has not) may have a good basis in common sense: the individual can, in this way, make sure that he does not suffer too much from other people's personal likes or lack of judgement. Nevertheless, the response is conservative, and impedes innovation in the human environment in a way quite out of keeping with an age of experimentation and technical discovery. In discussing building design it is therefore necessary to examine in some detail the attitudes and prejudices that shape subjective response; it becomes essential to analyse what is meant by the universally held belief, 'I know what I like'.

In any study of satisfaction there is the additional problem that people are probably not able to be objective about individual features in their environment, but respond to the 'halo' effect of the situation. That is, their judgements depend a great deal on the total satisfaction they get from a situation, and this will largely turn on social relationships. This, of course, implies that strictly, studies of amenity are not separable from studies of the total psychological situation.

Personal and social effects

The study of the individual and social effects of an environment is necessarily a task for specialists, ie, 'human scientists', but the interests of the two main groups – sociologists and psychologists – are different. For example, recent advances in electronic data processing, with its many implications for clerical workers of automation, have created a good deal of interest.[10] Sociologists may ask 'what are the social consequences when automatic methods are introduced into an industry?', while the question for psychologists is, 'in what way are individuals affected when conditions in the industry change?' Such a change might result from the introduction of EDP systems or (the subject of this research project) from the physical setting for work. The transference of people from small heterogeneous groups composed of clerks, typists, comptometer operators and junior management, into formally determined homogeneous groups like large typing pools, machine rooms and document stores is one example of a change of environment which may affect individuals significantly.

In studies of people's response to environment, a building can be treated as though it is a catalyst, a relatively inert agent, but one vital to a particular process, in this case the work of the office. However, the building differs in a very important respect from the catalytic agents of chemistry. These facilitate only one kind of reaction between substances, whereas the building may facilitate many. For example, most people, both architects and laymen, would hold that colours, intensities of illumination, and textures are capable of influencing mood and feelings.

Another way in which a building interior may act as a catalyst to behaviour is through its arrangement of spaces. For example, common entrances to different departments mean that there are many more opportunities for inter-departmental contacts than if there were separate ones. The results of these interactions need to be studied from both the social and the company's points of view for the individual's social world is potentially widened, and it may well be that inter-departmental working is facilitated, by such informal contacts.

Yet another way in which the building may influence behaviour is by the size of the work room. What happens, for example, when a clerk moves from a small office setting to a large open one? In what way do his sentiments change towards both his immediate working group and

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5. **Strother, George B**: Changing concepts of teaching and research in business. Introduction to: Social science approaches to business behaviour (Ed: **Strother, George B**). Homewood, Ill: Richard D. Irwin; London: Tavistock Publications, 1962
6. **Rothlisberger, F. J.** and **Dickson, W. J**: Management and the worker. An account of a research programme conducted by the Western Electric Company, Hawthorne Works, Chicago. Harvard University Press, Cambridge (Mass), 1939
7. **Strother, George B**: op cit (5)
8. **Jahoda, Marie**: (in a paper to the annual conference of the British Psychological Society in 1963). See: Some social psychological consequences of architectural decisions. Abstract in Proc Brit Psych Soc Conf. Reading. Abstr Bull B P S. 1963 **16** (51)
9. **Raven, J**: (in a paper to the annual conference of the British Psychological Society in 1963). See: Human needs and the design of dwellings. Abstract in Proc Brit Psych Soc Conf. Reading. Abstr Bull B P S. 1963 **16** (51)
10. See, for example, **Scott, W. H**: Office automation and the non-manual worker. Organisation for Economic Co-operation and Development. Paris (The Organisation), ? 1962

his department or company as a whole? What group sizes tend to have cohesive and which disintegrative effects on social and working groups? Are they affected at all? How does the individual's concept of himself change; does the worker regard himself as reduced in stature by being given less obvious prominence in a larger group? Does he feel more or less ambitious in the new setting? Are there more far-reaching social consequences?

Many personal relationships will undergo radical changes when new policies for the grouping of staff are introduced. The middle grade clerical worker who previously had a regular typist, or even a secretary, may now work with a pool typist, or more frequently, a dictating machine. The typists will work in a typing pool and no longer have a boss or a personally responsible place in the life of a department. The changed relationships between people can be expected to have important counterparts within individuals.

Formalisation, and the concentration of working groups, offer many opportunities for the introduction of more autocratic measures in the supervision and management of staff; this is another way in which the individual and social status of the office worker may be affected by building design. It has been traditional that clerical workers, more than any other working group, have had the best chances for upward occupational and social mobility. Because of this, clerical work has drawn a much higher proportion of well educated people than could otherwise be expected. Managers, executives and even directors have been drawn from the 'rank and file'. With the changing structure of clerical occupations, and other social changes like universal literacy and increasing opportunities of higher education for the more talented, it is difficult to recruit the same level of individual. Instead his place is being taken by the female clerk and machine operator who are quite adequate for the mechanical clerical and accounting functions and other remaining clerical procedures which have been de-skilled by work study. The design of the work place must take into account not only the changing nature of clerical work, but also the internal changes that are taking place in clerical occupations themselves. [11]

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[11] For an examination of the evolution of office work from the sociological point of view, see **Lockwood, D**: The black-coated worker. Allen and Unwin, 1958

Stage Three
Part Two

The total environment

CIS
BAXENDALE L.C.

Chapter 10
The total environment

A case study of the CIS building in Manchester

The Pilkington Research Unit's long-term aim is the development of an environmental discipline in which the components are studied as a whole. This chapter consists of a case study of the total environment in Britain's tallest office building: the headquarters of the Co-operative Insurance Society Limited in Manchester, which was completed in 1962.[1, 2] The building consists of an extensive podium which is about 175 ft by 250 ft and contains the ground to fourth floors. A tower containing twenty-one further floors rises above. The staff number about 2,500.

The Unit's research interest in the building developed from a letter received from the General Manager of the CIS[3] who said that he had read of the office-building project in *The Guardian*[4] and would be glad to offer facilities for study. These were readily accepted, for not only was the building probably the most advanced of its kind in the country, but the physical and human problems of populating it with a large staff which had previously worked in a variety of conventional and much smaller office buildings presented an unusual opportunity to study the human aspects of a modern environment.[5]

An environment results from the satisfaction of a functional need for space. At its simplest, the requirement may be entirely utilitarian; in a more complex form, there may be substantial overtones of a subjective type, eg, 'the projection of the company image.' But with all design – even of utility buildings – decisions have to be made which involve the expression of subjective preferences. Translated into a building these decisions have a permanent effect upon people's behaviour and comfort. In this chapter an attempt will be made to describe how the environment of the CIS was created, how the decisions were made, what sort of environment has resulted, and how the occupants have reacted to it.

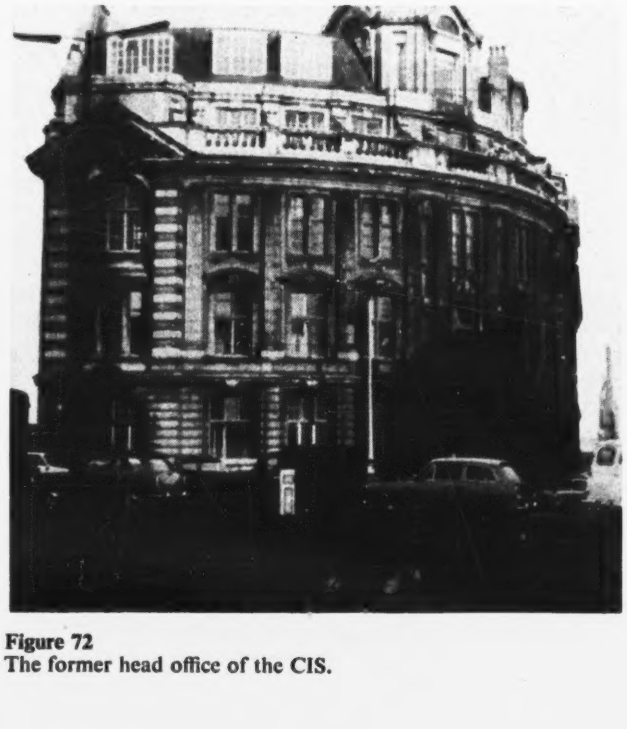

Figure 72
The former head office of the CIS.

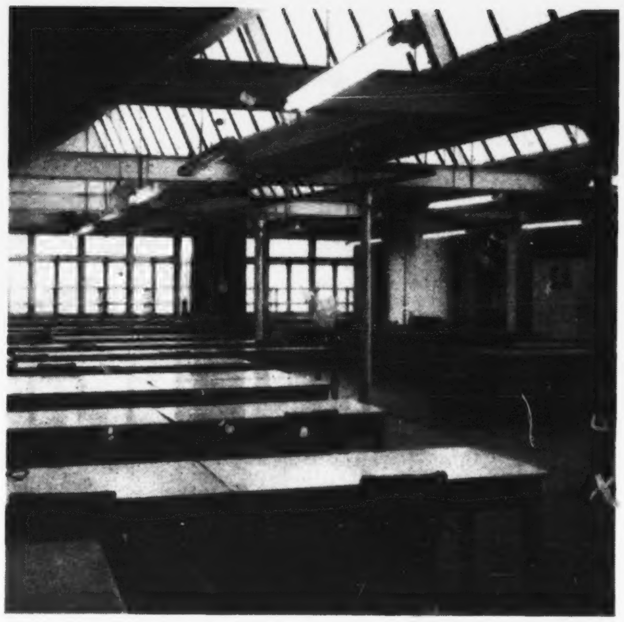

Figure 73
Interior of one of the offices used by the CIS before its move into the new building.

The reasons for the new office building

With the post-war expansion in commerce the CIS grew from being a comparatively small insurance company to one of the largest in the country; this resulted in an expansion of staff and radically increased space requirements. Post-war building, however, did not keep pace with this expansion and the CIS was obliged to

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1. For an account of the early studies (particularly the psychological investigations) in this building see: **Wells, Brian**: Psychology in the office. *The Guardian*, 1963 (October 23)
2. For a short re-appraisal of the CIS environment after its first 18 months in use see: **Manning, Peter** and **Wells, Brian**: CIS: re-appraisal of an environment. Interior Design. 1964 (July/August)
3. **Dinnage, R:** (Co-operative Insurance Society Ltd.): letter to P. Manning, 1962 (July 13)
4. **Anon:** Research unit's inquiry into office design. *The Guardian*, 1963 (July 12)
5. The building has been described and illustrated in many technical journals. See, for example, **Scott, Keith N:** Manchester's skyscraper. Archit. Build. News, 1963 (January 16)

rent eight other offices in the vicinity of its old head office. These premises, being old and scattered, created much unnecessary movement and delay in the processing of documents, and some inconvenience to the staff. In 1953 the Board decided in principle upon the building of a new office block.

The basis on which the site was chosen

The first major decision which had to be made was where the new building should be sited. The natural location appeared to be a site close to the existing main building. It was, however, considered wise to explore the possibility of moving to the suburbs because the building was to be an administrative head office and not generally used by the public. It was believed too that, away from the centre of the city, both site and building would be cheaper. It was also expected that staff would be easier to recruit.

The suburban site which appeared to offer the greatest advantages in terms of pleasant location, good transport, reasonable cost and a large potential labour force was at Wythenshawe, a Manchester overflow area. The labour position was felt to be particularly attractive as the Society was mainly concerned with recruiting women, and it was known that large numbers of office workers commute daily from there to central Manchester. In common with similar employers, the CIS has a rather high turnover of women staff, and expected that continuing losses in its head office force would be replaced by local workers.

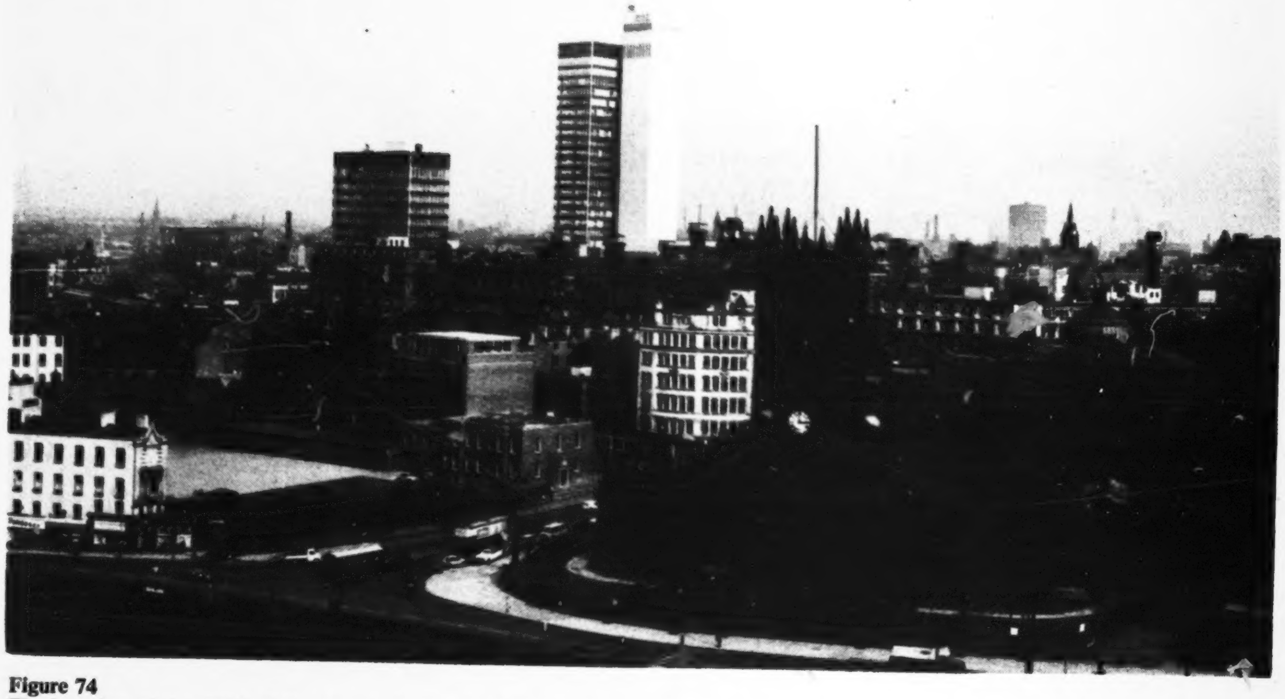

Figure 74
The location of the CIS building in relation to the city of Manchester. (The cathedral in the foreground).

However, the results of a pilot survey of the availability of female labour, conducted by the CWS Market Research Unit, indicated that girls were not interested in working in Wythenshawe, but wanted to travel into Manchester for shopping, for dancing during the lunch hour, and for many other city activities. The report was so positive that the proposal to move to a suburb was abandoned and it was instead decided to build in the city centre, on a site adjacent to the old head office building.

The company staff responsible for planning

The ultimate responsibility for planning the project was in the hands of a steering committee which consisted of three (later four) directors and two of the company's most senior executives: the General Manager and the Investments Secretary. No department was solely concerned with the project, and no senior staff were occupied full-time upon it (until a premises controller was appointed five months before construction started). The O and M section had been established too late to take much part in the design of the building and so heads of departments were given sole resonsibility for the layout of their working areas.

Other company staff closely involved, as executives rather than policy makers, were an assistant actuary and the premises controller. The assistant actuary was responsible for the mechanics of the move from the old premises to the new, and for providing management-staff communication on the subject through special 'newsletters' and articles in the house magazine. The appointment of premises controller was a new one, created specifically for the new building. His responsibility was to oversee the construction of the building and thus acquire an intimate knowledge of it, organise the occupation of the building, control the running of such services as canteens, recruit technical staff for the operation of the building, and provide planned maintenance and cleaning programmes.

The appointment of the design team

At an early stage in the Company's consideration of its new building, Mr G. S. Hay, Chief Architect to the CWS in Manchester, had been appointed architect for the development; subsequently Mr Gordon Tait of London was invited to act as Associate with Mr Hay. The joint architects then advised on the appointments of consulting structural, electrical and mechanical engineers. According to the General Manager, it had always been considered possible that the building would be fully air-conditioned, and the consultant mechanical engineer was therefore asked, soon after his appointment, to investigate the financial implications of such a decision.

A party consisting of a CIS director, the Investments Secretary, and two architects and the mechanical engineer made a visit to North America to study the design of tall office buildings, and the problems of heating, ventilating and airconditioning, and vertical movement of staff, mail and documents.

This visit appears to have had a major influence upon the building's design. On the deputation's return the architects were asked to prepare a scheme for a single large block of between 20 and 25 storeys, to proceed on the assumption that curtain walling would be used, and, providing the cost was not prohibitive, to employ full airconditioning. A previous intention of adopting open-planned offices was confirmed. The architects and probably the other members of the party, too, had obviously been greatly influenced by the work of the American architects Skidmore, Owings and Merrill, especially perhaps, by their administrative building for the Inland Steel Company in Chicago.

Later, a third firm of architects and interior design consultants (Design Research Unit) was appointed to take responsibility for the interior decor and furniture. The largest part of their interior design work is to be seen in the entrance hall, dining rooms, and in the executive suite, but they were also responsible for the partitions, furniture and colour schemes in the general office areas.

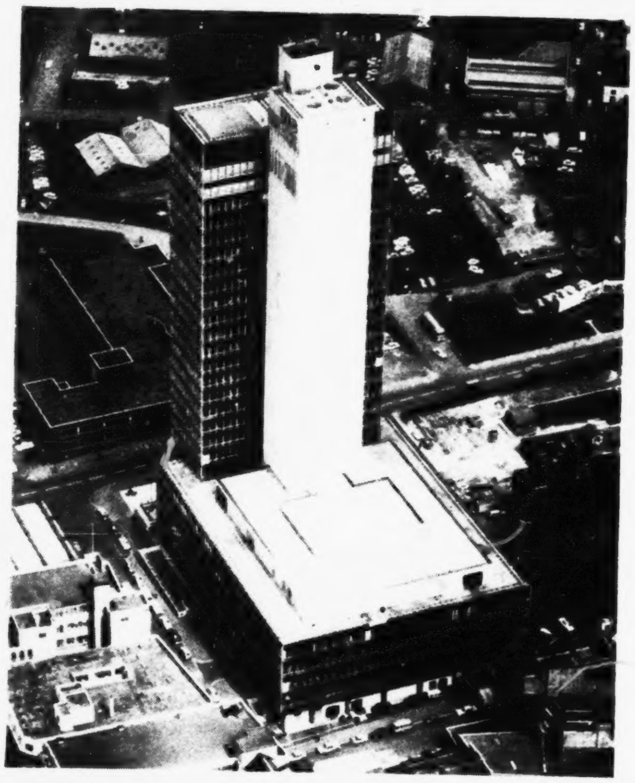

Figure 75
Aerial view of the CIS building which shows the three main components of its form: the office tower, the service tower, and the podium.

The reasons and policies underlying certain important features of the design

The building has two features which make it somewhat remarkable. In the first place it is unusually tall and secondly, the interior was conceived as an example of 'open planning'.

The principles for design proposed by the project steering committee were threefold:

(i) the building should add to the prestige of the Society and the Co-operative movement

(ii) it should improve the appearance of the City of Manchester

(iii) it should provide first-class accommodation for staff, with a view to attracting new and retaining existing staff. [6]

The General Manager has said, [7] 'If I may use a rather hackneyed phrase, we wanted to impress an "image" on the people of Manchester and elsewhere of the strength and size of the CIS through the medium of a modern office building. Very few people see our balance sheet or read our chairman's report but this new building will be a constant reminder that the CIS is a large and first-

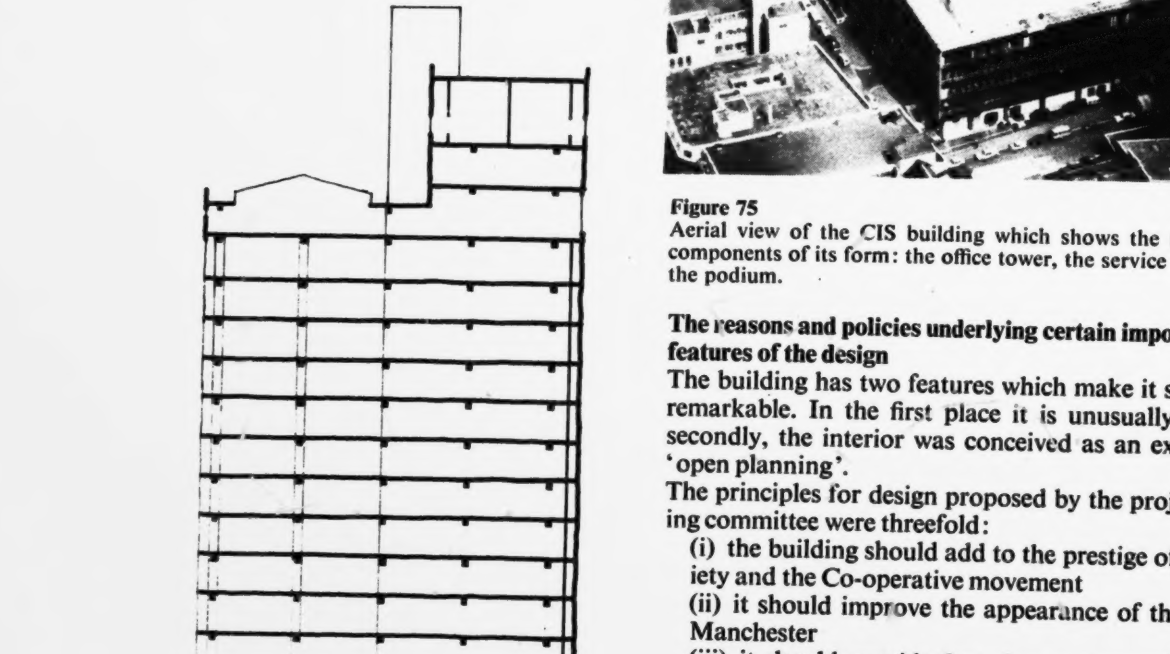

Figure 76
Section through the CIS.

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[6] **Dinnage, R:** Design policy for corporate buying. Paper by the General Manager of the CIS to the International Design Congress, 1961. (Duplicated typescript)

[7] **Dinnage, R:** op cit (6)

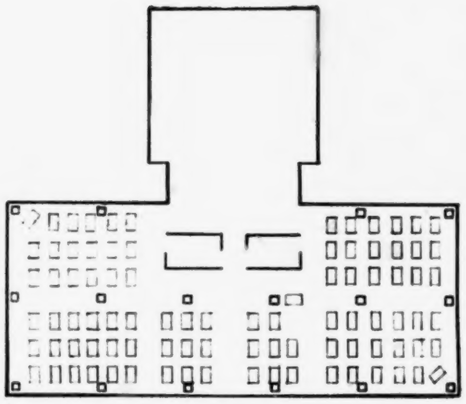

Figure 77
A typical open-plan floor in the tower.

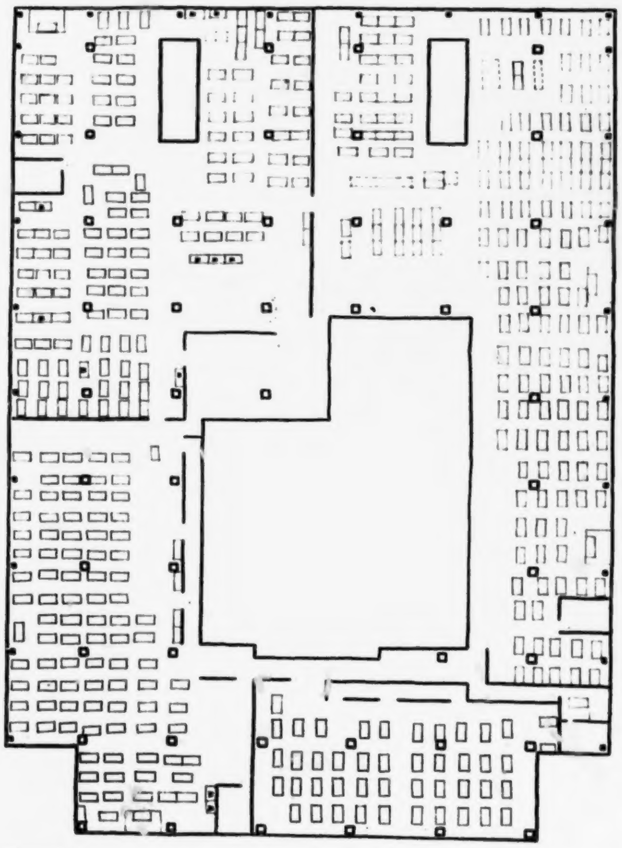

Figure 78
Plan of one of the podium floors.

class insurance office. We have already made use of the model in our advertising material and hope to extend this when the building is completed. We believe that these new premises will have an impact upon our staff, including the senior staff, by giving them a feeling of pride.'

One of the reasons for the original decision to use open planning was said to be that there is a work-flow in insurance just like that of industry. Examples were given of the processing of a new policy and the settling of a claim, where many departments would be concerned. The need for flexibility in both work-flow and departmental size, because of changes of work method and increasing mechanisation, was underlined. In fact, in many cases the policy does not seem to have been followed consistently and a substantial amount of partitioning has been used. The reasons for enclosing areas and separating departments have been sought, for this action was in direct contradiction to the stated policy of open planning. In the course of the project it seemed virtually impossible to determine a particular reason why this was done or who was mainly responsible. The management, however, do not necessarily endorse those impressions of their partitioning policy formed by the Unit and reported in this and the two succeeding paragraphs.[8]

A number of explanations has been given. One senior executive said that he had tried to imagine how youngsters and nervous people would feel when walking across one of the podium floors, each of which contains approximately 35,000 sq.ft of office space exclusive of service areas. He had felt that the open spaces and great numbers of people might result in unpleasant self-consciousness, and therefore decided to include a certain amount of partitioning to break-up these very large areas. Thereafter, partitioning had just crept into the plans of the tower floors.[9]

It is possible that the original conception of open planning was not strongly held, or that the custom of physically separating departments was too strong. It seems more likely, however, that many departmental managers had been vociferous – and successful – in their demands for partitioning around their departments. Some small areas within departments are enclosed by partitions. An explanation for this was given in terms of supervisor needs: a supervisor could do his job more easily if he could clearly see where his responsibilities ended. Asked whether supervisors would be able to supervise more efficiently if their sections were screened off and separated from other staff, a respondent replied that he could not think of any reason why this should be the case, but that supervisors preferred to be screened off from one another.[10]

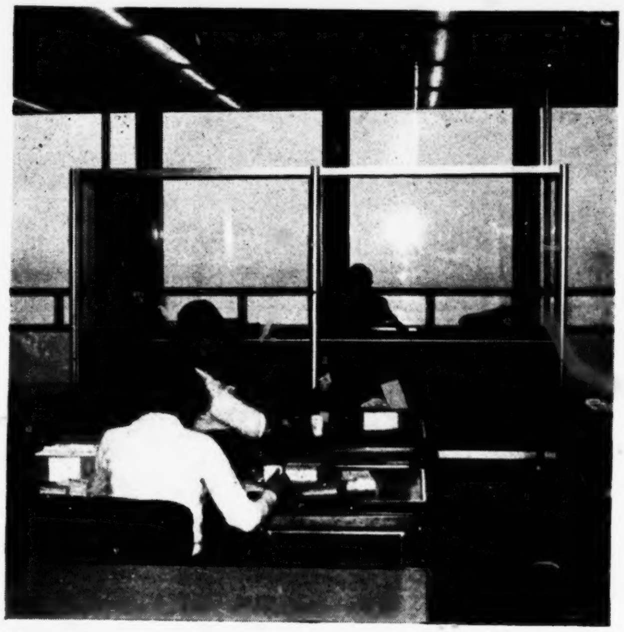

Figure 79
Chief clerks office.

The practice in the old office buildings, by which chief clerks had raised platforms approximately 10 ft square in size which were screened but not separated-off as offices has been carried over to the new building, where they have an area 2 x 2 modules in size (approximately 100 sq.ft) raised above the floor to a height of approximately 10 inches and surrounded on three sides by glass screens. The reasons given for the platform are better provision for the supervision of staff, a degree of privacy behind which clerks can be interviewed and a status symbol and prop to the authority of the chief clerks. In fact, as chief clerks are placed on the perimeter of the building so that they can face inwards towards the staff, some of them have difficulty in supervising because of the reflections on the glass of their partitions from the windows behind them. They can be easily seen but cannot easily see!

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[8] See footnote 9

[9] On seeing the draft of this chapter, the management stated that partitions have only been provided in the following cases:
- i. private offices for officials, which were always intended
- ii. divisions between quite separate departments
- iii. cloakrooms
- iv. storerooms
- v. interview rooms
- vi. where isolation was justified on grounds of noise

The management also states that *no* partitioning has been introduced 'to break up large areas ; no partitioning has 'just crept into the plans'

[10] The management emphasises that all supervisors do *not* have separately screened sections

Totally enclosed private offices were not envisaged at all in the early stages of planning but the strong objections put forward by the senior employees brought about a change in policy.[11] The system of private offices was simplified by having only two sizes, their allocation depending upon seniority, and available only to employees with the rank of 'official' (ie, executive). They are constructed of floor-to-ceiling partitioning which follows the line of the modules forming the planning grid for the office space. A clear criterion of the size of private office derives from the company's rating of seniority. The rank of 'senior official' entitles the holder to a 3 x 3 module (approximately 240 sq.ft) office; the rank of 'official' entitles its holder to a 3 x 2 module (approximately 160 sq.ft) office. The criterion is a clearly understood one, and has the rationale that senior officials are more frequently liable to hold conferences and receive visitors in their offices. The occupants of the 3 x 2 module office were given the choice of three complete decors but were not able to take part of one and part of another. Senior officials had a greater range of choice.

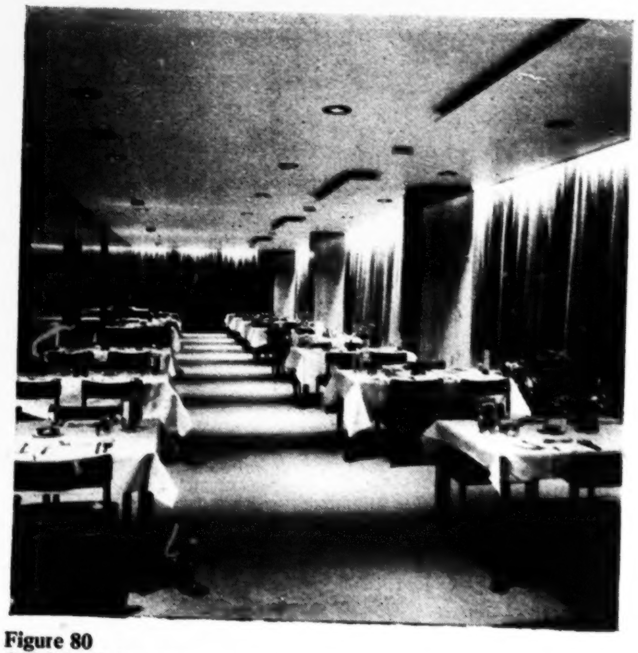

Figure 80
Officials dining room on the 24th floor.

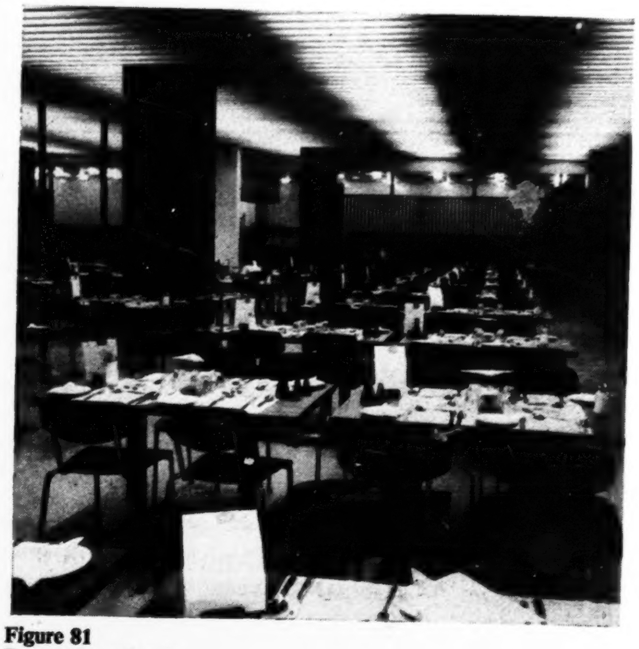

Figure 81
Basement cafeteria.

There were certain eating distinctions in the old premises; a staff dining room for the rank and file employees, a dining room for chief clerks and junior officials, and a separate dining room for senior officials. The new arrangement consists of three restaurants on the twenty-fourth floor and a cafeteria in the basement. Of the restaurants, one is for visitors, one for all grades of official and another for chief clerks. Junior officials and chief clerks have now moved apart; as one chief clerk described it, into officers' and sergeants' messes. Rank-and-file members of the staff eat in the basement cafeteria. It seems unfortunate that there should be a physical separation of twenty-odd floors between the two sets of dining services, for not only must this be an uneconomical arrangement, but it introduces the possibility of the creation of a substantial psychological gulf between management and workers.

The physical environment

Spatial

The use of a plan-module for the office space has already been mentioned; its dimension is 5ft 2in. in both directions, determined, so far as can be seen, quite arbitrarily. It consists of a square of twenty-five 1 ft square floor tiles bounded by a 2 inch wide strip. The ceiling has the same overall pattern of 5ft 2in. squares, but it has a marked directional character, for the finish consists of ribbed metal pans with a recessed 5 ft by 1 ft light fitting in the centre.

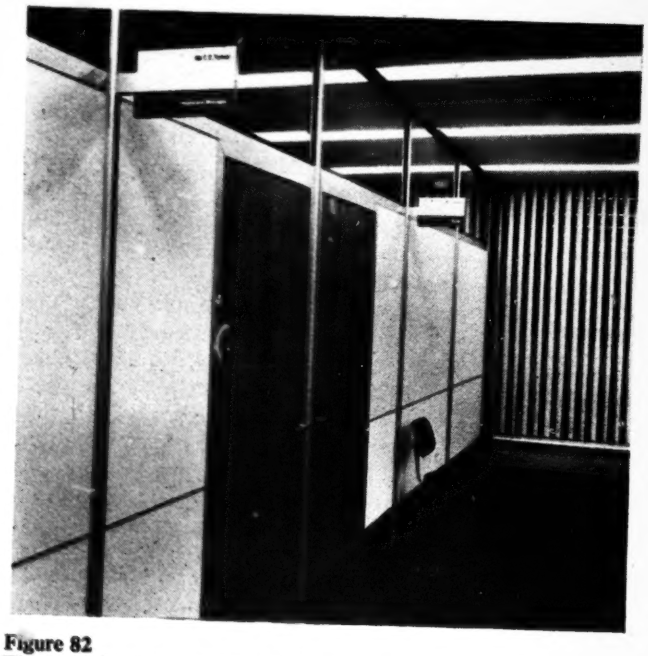

Figure 82
The modular basis of the design.

The total area of *office* space (ie, excluding lavatories, lifts, stairs, etc.) on one of the podium floors is about 35,000 sq.ft; on one of the tower floors about 7,500 sq.ft. Gross areas per clerk (ie, including circulation, coat hanging space, etc.) vary from about 77 sq.ft in the more densely occupied podium floors to 83 sq.ft and upwards in the tower block. Net areas per clerk (ie, the actual desk and chair space and immediate circulation) range upwards from about 45 sq.ft.

Visual

The outer walls of the CIS are clad with an elegantly detailed system of curtain walling. Glazing extends from the top of the perimeter heater outlet (which is only 9 inches high) to the ceiling, and there are no opening lights. Although the 'window' area is so extensive, it could not be sufficient to provide an adequate amount of daylight for working in the inner areas of either podi-

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[11] The management has explained that the occupants of the private offices had some influence upon the decision to change from partial screening to full-height screening

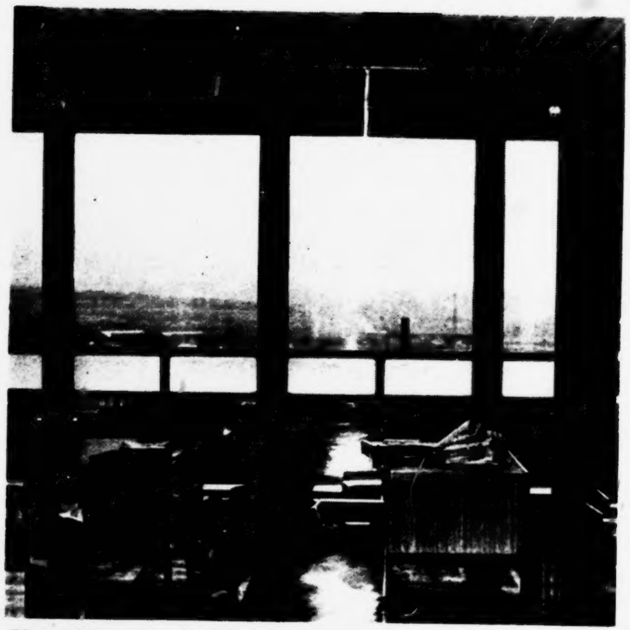

Figure 83
The glass curtain wall.

um or tower. This was clearly recognised at the design stage by both architects and owners and the electric lighting installation is used constantly and without restraint. The windows in the tower provide magnificent views and adjustable vertical white blinds, which are both attractive and efficient, are used to provide protection from sun or sky glare.

Levels of daylight in this building have not been measured, for they would be largely meaningless. Most, if not all, of the 19 tower office floors receive daylight from a virtually unobstructed sky, but much of the podium, in which rather more than half the total number of staff work, is obstructed by nearby buildings.

The electric lighting installation consists of one 5ft 65 watt 'warm daylight' fluorescent tube per 5ft 2in. square module mounted within a fitting whose plastic louvred under-surface is flush with the ceiling. Measurements of the illumination at night[12] have shown the typical range of illumination on the working surface of desks to be between 24 and 30 lm./sq.ft with a mean of 28 lm./sq.ft. The ratio of minimum to maximum illumination is 0.8, so that both the value of the illumination and its consistency are high – though the working illumination is not so high as the value of 36 lm./sq.ft which was intended. It has only been possible to estimate the glare index; it seems, however, that the value achieved is lower (ie, better) than the recommended 19.

The reflectivities of the ceiling and desk tops are fairly high (75 and 32 percent respectively) but the floor is very dark (8 percent) and because so little light is reflected back to the ceiling, this surface appears dark too and, especially in some areas of the podium, gives a rather gloomy impression of the interior.

Thermal

The design criteria for the heating, ventilation and airconditioning of the office areas were:[13]

Winter	70°F air temperature
Summer	75°F air temperature
Relative humidity	50 percent at all seasons
Fresh air changes per hour	2.0 to 3.9 (a minimum of 3.1 in the podium)

The airconditioning for a typical tower block floor works in the following way. Primary air, discharged through nozzles within induction units situated on the perimeter of the floor, induces a flow of room air through a re-circulation grille at the front of the unit. The re-circulated air passes through a coarse filter and over a coil (which is either heated or cooled) before mixing with the primary air and being discharged into the room through the top grille.

The air from the central part of each floor is cooled if necessary and filtered by re-circulation plants in the service tower, the air being extracted and supplied through dual-purpose light fittings.

Because of the lightweight construction, the building has a low thermal capacity and therefore an elaborate control system is used. The secondary water and the air distribution systems in the main tower are arranged in several zones according to height and aspect. The temperature of the water supplied to the units is adjusted for each individual zone to suit the outdoor conditions.

The podium also has perimeter induction units, but because of the very large floor areas additional air supply is necessary in the central working areas. This is provided through dual purpose light fittings and a high velocity distribution ductwork. The air is re-circulated in these areas through the light fittings, alternate fittings being used for extraction.

All boilers, refrigerators, pumps and other air conditioning equipment are controlled from a central panel in the boiler house.

Surveys of the thermal conditions in this building were made during both winter and summer.[14]

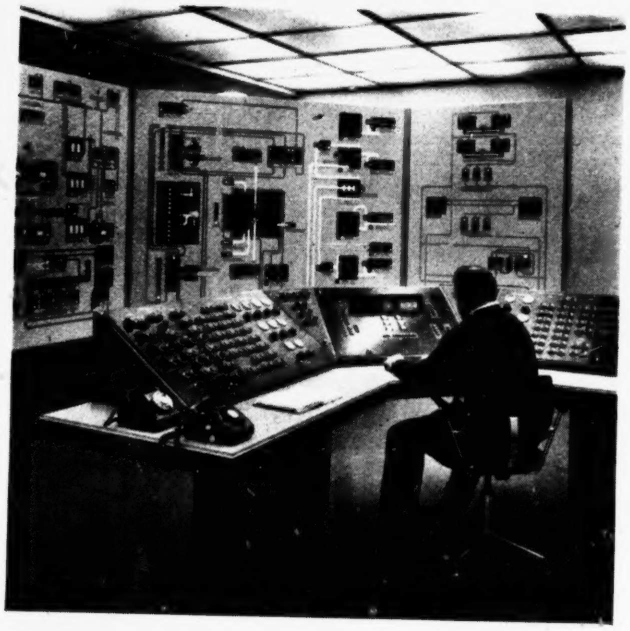

Figure 84
The central control in the basement for the thermal environment and mechanical services.

There were two surveys of *winter thermal conditions*. One was in January 1963, during a period of continuous frost. On this occasion, a number of measurements were taken on the eighth floor, which is completely open and without any private offices, over a period of 2 days. The number of occupants at the time of the survey was about seventy-five. The arrangement of the desks was such that no person was seated nearer than 4 ft to the perimeter heating and airconditioning units. The globe thermometers which marked the measuring stations were distributed over the occupied area, none being nearer to the windows than 4 ft.

During the two mornings of the survey external conditions were very similar, as indeed they were inside the building. There was a slow rise in the mean globe temperature on both days and, as might be expected for periods without direct sunshine, the maximum globe temperature was recorded at a station near the centre of the room, the minimum on the northern side of the building. During the afternoon, and due to some sunshine, globe temperatures at two positions on the south-western face of the building increased to above 75°F. In comparing the results obtained in this office with the comfort ranges quoted in chapter 7, it was found that:

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[12] See chapter 6 and appendix 6.2

[13] **Anon:** Air conditioning for the Co-operative Insurance building, Manchester. Heating, 1962 (September)

[14] See chapter 7 and appendices 7.1 and 7.2 for a brief account of these and other surveys of thermal conditions in offices

(i) the relative humidities were all well within the range 30 to 70 percent

(ii) the rate of air movement seldom rose above what is considered to be the upper limit for the comfort of people doing sedentary work. Values of 40 ft/min. or above were recorded for only 6 percent of the total readings, and none were above 43 ft/min. The average values of air movement were about 23 ft/min

(iii) the mean globe temperatures varied throughout the two days by about 2 deg F; the variations of the globe temperatures at individual positions were similar to the variations of the means except when the sun shone brightly. Horizontal temperature gradients were small except during periods of bright sunshine

(iv) in contrast with the results of some other surveys,[15] air temperatures in this office (mean values of between 73 and 74°F) were high

(v) equivalent temperatures were generally within the range reported as being suitable for normally clothed sedentary adults, of 66 to 72°F.[16] The upper limits of the comfort ranges were exceeded for short periods only when there was direct sunshine, and this could have been avoided if the venetian blinds had been drawn more often

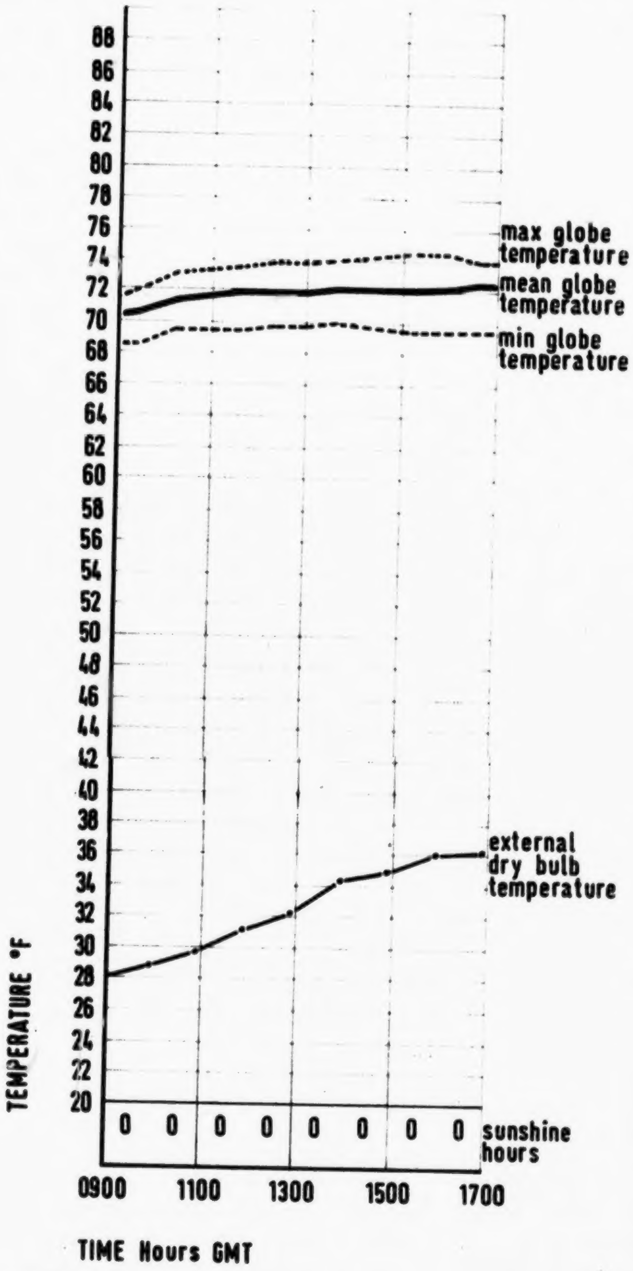

Figure 85
Globe temperatures on the eighth floor during 15 January 1963.

(vi) the vertical temperature gradients were small, none exceeding 3 deg F between floor and ceiling.

Similar surveys of *summer thermal conditions* were made, again on the eighth floor, during the period 11th to 13th June 1963. A maximum shade air temperature of 80°F was recorded at the nearby meteorological station on June 11th; maximum CET inside the building at positions not in direct sunshine was as high as 72°F. Globe temperatures of over 80°F were recorded at only two positions. These occurred between 1300 and 1420 hours at a position near the southern corner and, after 1600 hours, at a position on the western corner where, because the blinds had not been drawn, the sun had shone directly onto the globe thermometers.

The next day was not quite so hot nor was the sunshine so prolonged, but external air temperatures were above 70°F for the greater part of the working day. The mean globe temperatures varied between 74.0 and 75.2°F; the highest reading was 80°F.

On the 13th June there was an abrupt change for the worse in the weather, but globe temperatures were only a few degrees lower than on the previous days. Air temperatures varied between 73°F on the 11th to 70°F on the 13th. Relative humidity was stable at 50 to 60 percent. The rate of air movement varied between 12 and 40 feet per minute with an average of 23 ft/min.

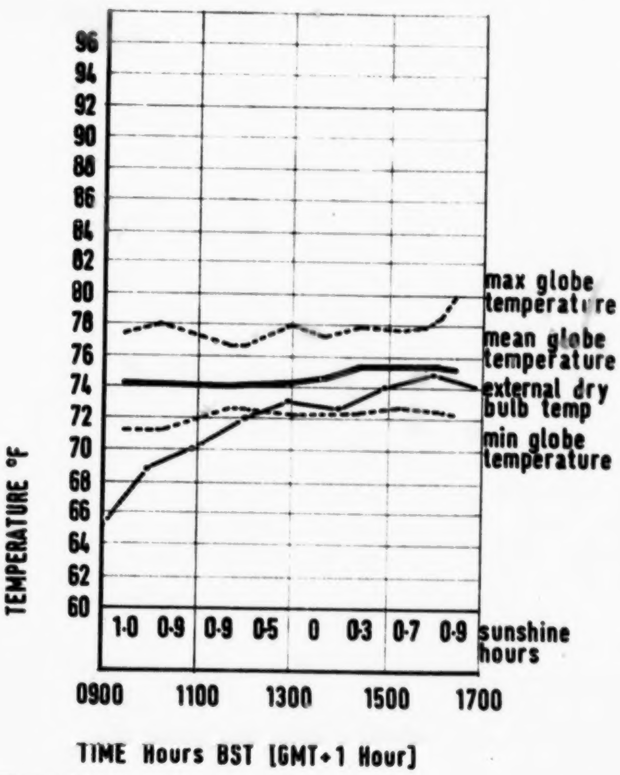

Figure 86
Globe temperatures on the eighth floor during 12 June 1963.

Aural

Measurements of noise level were made on the ground, second, fourth, eighth, and twenty-third floors, and included four large general offices, two machine rooms, a conference room, a private office and the staff cafeteria. The noise in the occupied general offices originated mainly within the rooms. In the large general offices on the second floor, ie, the largest and most open space in the whole building, the noise levels complied with Beranek's criteria[17] and the highest reading was only 2 dBA above the Wilson Committee's recommendation[18] of 55 dBA. Although the noise levels in the machine

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[15] See, for example, **Black, F. W**: Desirable temperatures in offices: a study of occupant reaction to the heating provided. J Inst Heat Vent Engrs. 1954 (November)

[16] **Billington, N. S**: Comfort at work. J Inst Heat Vent Engrs. 1953, 21 (215) 141-4

[17] See chapter 8

[18] **Committee on the Problem of Noise**: Noise: final report. Cmnd 2056. HMSO, 1963 (July)

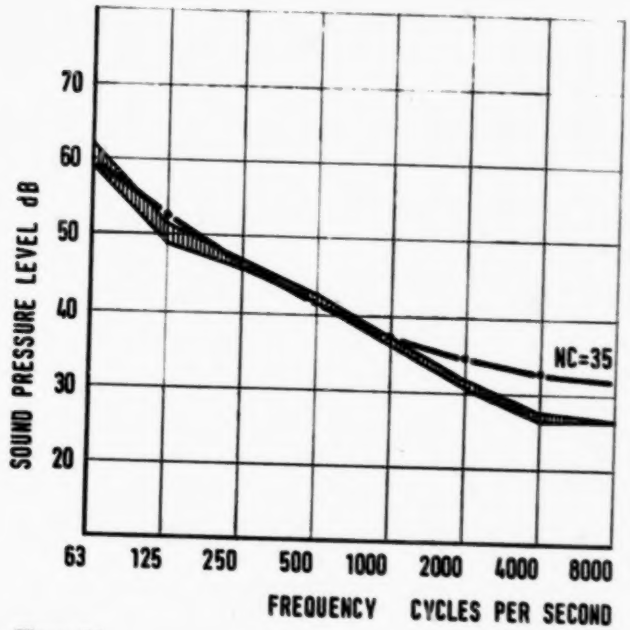

Figure 87
Noise spectrum in unoccupied conference room on twenty-third floor (43-44 dBA).

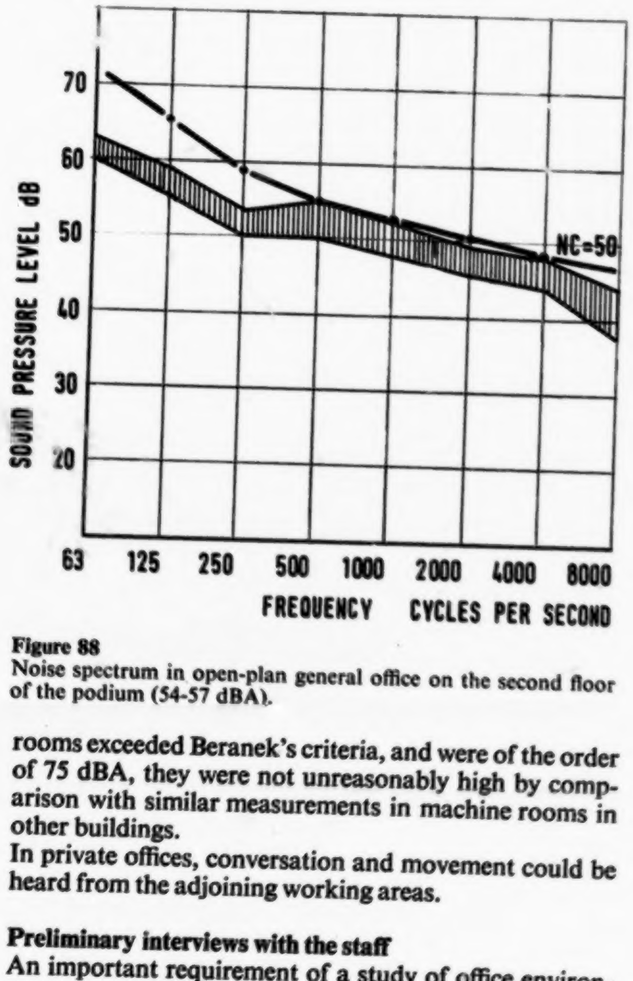

Figure 88
Noise spectrum in open-plan general office on the second floor of the podium (54-57 dBA).

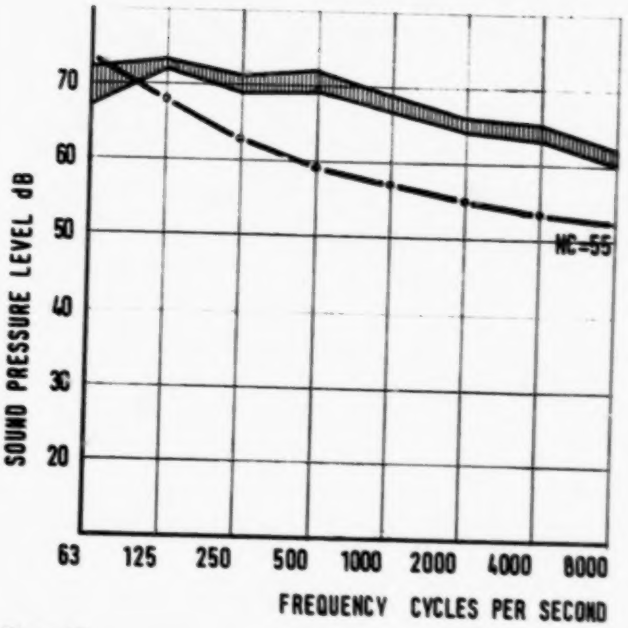

Figure 89
Noise spectrum in card punching room where twenty-eight machines were working (70-74 dBA).

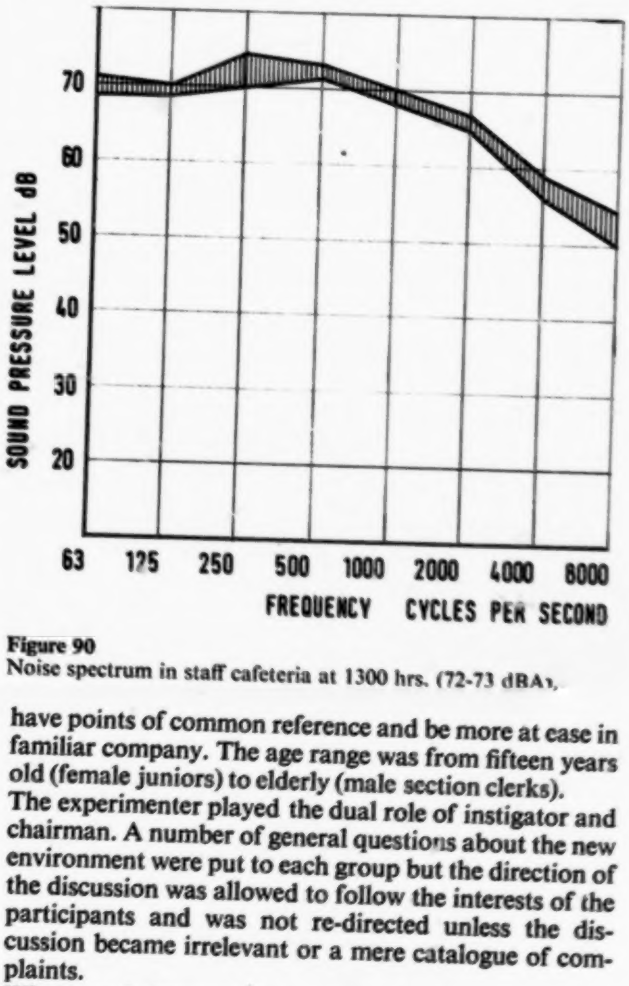

Figure 90
Noise spectrum in staff cafeteria at 1300 hrs. (72-73 dBA).

rooms exceeded Beranek's criteria, and were of the order of 75 dBA, they were not unreasonably high by comparison with similar measurements in machine rooms in other buildings.

In private offices, conversation and movement could be heard from the adjoining working areas.

Preliminary interviews with the staff

An important requirement of a study of office environment is a specification of those features in a building which are influential in determining a person's subjective reactions to his workplace. In order to obtain this representatives of the rank-and-file clerical workers were interviewed, and their views on any aspect of the environment that they felt to be important to them were sought. The interviews were completely free-ranging, though the experimenter made sure that a number of specific topics were introduced.

Eight discussions were held, on each occasion with groups of six plus the interviewer. The composition of the different groups varied considerably in respect of age, sex, occupation and status, but the composition of a particular discussion group was usually fairly homogeneous. The participants were always drawn from the same department so that the members of a group should have points of common reference and be more at ease in familiar company. The age range was from fifteen years old (female juniors) to elderly (male section clerks).

The experimenter played the dual role of instigator and chairman. A number of general questions about the new environment were put to each group but the direction of the discussion was allowed to follow the interests of the participants and was not re-directed unless the discussion became irrelevant or a mere catalogue of complaints.

What was being sought from the meetings was not an appraisal of the building but an estimate of the features that were subjectively of greatest importance, for the interviews were to act as a guide to the questions later to be asked in questionnaires. Obvious features such as heating, lighting and ventilation were raised, together with more general questions about liking the new building. The following is a summary of the sort of attitudes commonly expressed and the quotations, where used, have been selected because they were typical.

Because the interviewer had to start the discussion, a number of specific questions was asked about the airconditioning induction units which, to the staff, represent the heating installation. The first transcription comes from a single interview with a group of typists. It was typical of the response to the system in the early

Figure 91
Interview with a group of clerical workers.

days of occupation when teething troubles were being sorted out, and it also suggests that position in the room was an important variable, a view supported by other testimony.

(*Interviewer*): '*What about the airconditioner: do you find it to your liking?*'

'No, we don't.' (loud agreement)

'I've got cramp up my arm and up my back'.

'It isn't constant: you perhaps go in in the morning and it's really warm, so off comes your cardigan and you're really warm. You've been in about an hour or so and then it goes cold and you start getting a terrible draught on your feet, and this week we've noticed it as though it's going up to the ceiling and then hitting you on the back of the neck'.

(*Interviewer, to girl who had not agreed with others about draughts*):

'*How about you, do you get draughts?*'

'I don't know, and yet the girls on the next row of desks say they do. We don't notice it much where I am'.

Also germane to the discussion of the airconditioning system were questions of stuffiness and odours. Odours did not seem to present much of a problem, but the number of reports of stuffiness raised the question whether this might be due to the individual's working position on a floor, or the density of occupation of that floor.

The cleanliness of the new building was a question which was also relevant as the building is effectively sealed and the entire intake of air is filtered before being circulated. A girl commented: 'Here you keep nice and clean, whereas before you were never clean. Your underclothes were filthy, and your body was filthy with the dirt you were kicking up, but here the atmosphere is very, very clean'.

Irritation with the noise made by the ventilating system was sometimes mentioned, as was the noise of the mechanical document conveyor, but most people commented on the comparative quiet of the new building. This was perhaps not surprising as the former head office stood beside a main line railway station.

Floor treatment was a topic in which almost no one was interested (possibly because it is a good surface) and, in itself, provoked no comment. There was a number of complaints from women that they were being made to wear flat heels so that they did not damage it. The senior management, however, has disclaimed any knowledge of such a directive and pointed out that only negligible damage to the office floors has occurred, although stilletto heels are now freely worn.

Ceiling height was treated more seriously. It emerged many times that those who found it too low were those who either sat in the middle of the room or who sat facing inwards. Many used the epithets 'oppressive' or 'depressing' to describe the effect of a low ceiling.

The colour scheme was a topic which provoked a good deal of discussion and disagreement. It was not possible to form any general impression as the range of agreement and disagreement was very great and did not appear to be associated with age, sex, place where the respondent worked, or indeed anything else.

Lighting, both daylight and electric, is one of the most important components of the internal environment. Yet, surprisingly, it was not a topic which created much comment or feeling. The following was typical of many discussions:

(*Interviewer*): '*What about the lighting, is this adequate?*'

'Oh, the lighting doesn't bother me personally'.

'I like the way it's covered up – you don't get the glare from it'.

(*Interviewer*): '*Oh, I see, you're talking about the fluorescent lights; I was thinking about the illumination in general*'.

'Oh, I think it's quite light enough'.

'I've got no complaints about the lighting'.

(*Interviewer*): '*What about glare from the windows?*'

'No, no we don't get any of that'.

'We haven't had anything like that'.

'The only thing is on the other side of the building, if it's sunny, you get the sun. But then, of course, you've got the venetian blinds and you can just adjust them to keep the light off your face without making it dark'.

However, a view through the windows was felt to be of great importance; not necessarily a pleasant view but merely the opportunity to see out. The following arose when the colour scheme (not the fenestration) was under discussion:

'The windows here are marvellous because, before, we were caged in by bars and windows that you couldn't look out of at all. So the windows, lighting and pleasant surroundings here are a great boon.'

'Well, in the room we were in before it was just four walls with windows up in the roof.'

'You didn't know what it was doing outside unless it was brilliant sunshine beating down on the back of your neck (laughter). But apart from that you didn't know what the weather was like; whether it was rainy or foggy, or quite nice. Really you had no idea.'

The feeling that it was important to be able to see what was going on outside was very widely held. The opposite view was never strenuously put in discussion, although a small proportion of people felt that it was a question of very little consequence.

Of the specific features discussed, the one which occupied the greatest amount of time was the lavatory facilities. Men were much less interested in the toilet accommodation than women, but nevertheless they rated them high on their list of priorities of office design. A number of specific criticisms were made of the new lavatories (even though they are of a standard very much higher than is usual), mainly in terms of overcrowding, overheating, wash basin design, and the lack of space for standing handbags. The men's concern was more in terms of privacy, cleanliness, and number of fittings. By contrast, the emphasis of the womens' interest was on the attractiveness of the toilets. One girl commented about the lavatories in the previous office:

'It was a horrible place and made you feel contaminated by going in there, and it was very gloomy and depressing'.

Other typical comments were:

'Nice toilets seem to add to your personal comfort somehow'.

and

'It plays a big part in your working day.'

Toilets are also places which women connect with their personal attractiveness, places to appraise themselves in a mirror and to make-up. They stressed the need for nice colours and elegant fittings and felt that these spaces should be at least as well appointed as the rest of the building.[19]

Apart from the discussion of the physical characteristics of the building, a good deal of time was devoted to intangibles, like the effects of the new building on such matters as personal relationships, work attitudes, and morale. Such discussions largely arose from the probing of attitudes to the building in general, to tower block design, and to the open planning of the interior.

A large proportion of those people interviewed were proud of working in this tall and very impressive building. One clerk expressed it this way:

'I feel very different when anybody says to me, "Where do you work?" and I say "at the CIS" and they say "Oh, that big place". You feel different'.

'I don't know. You don't feel as if you're someone but you see they seem interested. I don't know, you just feel different with working somewhere different . . . I don't know what it is, but I think most of us feel that way'.

Although no one confessed to being personally afraid of the height, many people commented that there were plenty of others (always supposed to be female), who were. Several people said that they would be very unhappy if the horizontal members of the windows were not there.

The discussion of the new building often led to considerable talk about staff/management relations. Many people felt that these had suffered with the move into the new building. There was a feeling that the rank and file were being regimented.

'It's more like the army now'.

and

'There are too many regulations; it was very easygoing before'.

This appeared to be due, in part, to the management and supervisors' zeal to keep everything crisp and tidy; to ban any personal effects, and to insist on desks being tidied every night. The new, more autocratic form of supervision was regarded as being a consequence of the large offices, which it was felt, foster a passion for symmetrical layouts and obsessional tidiness. Section clerks, used to more autonomy and privacy, commented on the question whether they would rather have partitioning between sections:

'Oh, yes, partitioning is important. It's very distracting having other sections around you, maybe having discussions or something'.

'Say something has gone wrong on your section, you can't tell your people off in private without every other section knowing about it'.

(*Interviewer*): '*Do you find it easier or more difficult to supervise what's going on?*'

'Well, I don't say it's more awkward but, if something goes wrong, they've all got to know'.

Typical comments from rank-and-file clerical workers were:

'You feel guilty when you get up'.

and

'You feel self-conscious if you have to walk across the room to the front of one of the cabinets. You walk back across the room again and you feel – I don't suppose you are – but you feel that you're being watched'.

Perhaps most commonly of all though:

'You feel they've got you where they can keep an eye on you'.

At a more general level, many people felt that they would prefer to work in a smaller group:

'You get a more friendly atmosphere in a small place'.

There was a great deal of indirect criticism of the new building in people saying that they had been much happier in the previous office, despite the poorer physical conditions.[20]

These comments, of course, are no more than impressionistic, and it must be emphasised, were obtained soon after the move into the new building and at a time when many of the staff may have been feeling uprooted from a way of life to which they had grown accustomed. They do, however, provide an overall view of the attitudes of the staff towards their management and their new building, at that time. The questions were not always the same, and the emphasis of interest varied with every group. Their value was not intrinsic, but consisted rather in providing an exploratory and descriptive background to a more comprehensive study. The impressions gained from them were subsequently used in the planning of questionnaires and more systematic surveys, experiments, and programmes of interviewing.

The questionnaire surveys of environmental conditions

The first questionnaire

Having learnt, from interviews, something of the staff's response to their building, the next step was to examine these attitudes in a more specific way and on a larger scale. The method adopted was to circulate[21] a questionnaire to all the 2,500 employees, the replies to which were then analysed statistically.[22]

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[19] It is interesting to note that the standard of care taken by employees in the toilets has improved out of all recognition. A 5 pm inspection of all male and female toilets showed them to be immaculate: this was certainly not the experience in the old buildings. It seems, therefore, that the provision of higher amenity levels has resulted in much better behaviour and treatment of the property

[20] These comments stimulated an interesting remark from the management, which is reproduced: 'This is a strange reaction and, in my experience, true but possibly transitional. I have concluded that the more perfect one makes the environmental conditions the more the occupants will complain about deviations from the ideal. An example of this occurs during hot weather conditions when the occupants readily complain if the temperature inside the building reaches 74°F when a telephone call to neighbouring non-airconditioned buildings shows that temperatures of 80°F are being suffered without complaint. The simile of spoiled children comes to mind and if the criterion is a happy atmosphere and not an efficient and healthy one then the C.I.S. building may not be the right answer. For this reason social amenities become very important. Nothing has been said of our social amenities in the report, and it may be that they are an essential integral part in modern design to counteract the "regimentation," the "regulations" and the "coldness" referred to in the report'

Perhaps the first thing a building owner and architect would want to know from such an enquiry is whether a building had been produced which was satisfactory for the greatest number of people. The best indication of this is provided by the response to one of the groups of questions: more than 80 percent found their work no less enjoyable in the new building than it had been in the old and three-quarters of these actually stated that their work had become *more* enjoyable. 73 percent of the staff said that their personal relationships with their colleagues were either unaffected or even more friendly than previously (the remaining 27 percent found their personal relationships less friendly). Only a small number disliked working in a tall office block; 75 percent preferred the new building to the old. Taking the building as a whole, there is little doubt, then, that it is well-liked by its occupants.

The teething troubles with the airconditioning system have already been mentioned; the first questionnaire showed that the uncomfortable thermal conditions which were experienced in the early days of the building's occupation weighed very heavily with the staff. Lifts, too, were initially troublesome, and a majority of the users were critical of their functioning. Nearly 40 percent of the staff considered that the toilet accommodation was inadequate in some degree.

In spite of the impressions given by the interviews, the ceiling height was generally approved, and over 80 percent found the electric lighting satisfactory. Very few people were aware of any glare from the windows. 65 percent never found their office distractingly noisy. The colour scheme, however, came in for a great deal of criticism; it was the characteristic of the environment which the greatest number of occupants felt might be improved.

Asked to check a list of words they considered descriptive of their building, the majority of the staff expressed themselves in terms which were, no doubt, the guiding aims of both owners and architects: modern, light, comfortable, pleasant, friendly and efficient.

There was no significant change, for better or worse, in the number of people suffering from headaches or eyestrain. A question was asked about attitudes to the new staggered working hours which were made necessary in order to relieve the load of a concentration of staff on both the lift service and public transport system. The psychological interest of the question lay in whether the move into the new building had created any substantial measure of discontent and, if it had, whether it was influencing people's general satisfaction with the new building. In fact, less than one-fifth expressed any sort of disapproval.

The remaining questions differed from the others in that they did not call for a direct assessment of the actual environment, but instead were concerned with the individual's assessment of the ideal environment. Asked whether they felt it important to be able to see out of the office, even if there was plenty of electric light to see by, the response was overwhelmingly that it *was* important. Another question asked whether it was as good for the eyes to work by electric light as by daylight: consistently, the great majority felt it was better for their eyes to have daylight to work by. It must, however, be noted that though these questions are complementary in some respects, the underlying attitudes and beliefs upon which they depend may be very different. For this reason, they were subsequently made the subject of a specific experimental study which has already been reported in chapter 6 (the visual environment).

A final question asked in what sort of office the respondent would prefer to work, and offered three alternatives. 28 percent opted for a large open one, 45 percent for a smaller partitioned area, and the remainder stated that they had no preference. The result is interesting, for the conception of the building is basically an open plan. The fact that nearly half the staff said they preferred a smaller partitioned area, must constitute an implicit criticism of the type of accommodation provided. The question of optimum size for working spaces has been the subject of further study.[23]

Summarising the findings of a broad analysis of the first questionnaire, it was found that the building was generally regarded with favour by the majority of occupants, in spite of strong criticism of a number of features, notably the lift service and the airconditioning (both of which have been improved since) and the colour schemes.

Without going into the detailed analysis of the answers to the questions it is possible to make some general comments about the pattern of the results. The position or aspect of the building at which the individual works did not seem to have a very great influence upon the way he responded to his environment. It may be, of course, that there were marked differences in particular cases, but it did not seem that this variable had much general influence. There was a significant difference in the answers of men and women to nearly all the questions, and this is a finding of considerable importance.

The influence of floor was very marked indeed. It was not surprising to find that the ground and first to fourth floors in the podium produced consistently significant results. This might have been predicted from the obvious physical differences between them and the tower floors, although it would be hard to specify *a priori* (or from the physical measurements which have been made) the causes of such marked differences. Significant differences between most of the floors were found to exist but most such differences are explicable in terms of their manner of use and type of staff. For example, some floors are predominantly typing pools or machine rooms, others house such specialists as solicitors in private offices.

The younger workers have a different view of their surroundings from their elders, and this is not surprising, particularly as the building is so much a product of contemporary thought. It would be interesting to trace further the direction of their opinion and see whether they are the most satisfied or the hardest critics of the design. This is something which is not easy to guess for it depends upon their expectations and these, presumably, are less influenced by experience than those of the older groups.

Of the male grades only the officials stand out. The reasons may be in terms of their general level of satisfaction with the amenities they and their departments enjoy, or it may reflect vested interest: many officials were personally involved with some stages of the planning and layout and they were all given private offices with a choice of carpet and colour schemes. Their physical conditions are, therefore, completely different from those of all other staff. Finally, the very fact of being in a small office implies a different experience of the airconditioning unit which was the source of much general criticism.[24]

The second questionnaire

The first questionnaire enquiring into staff reactions to the physical environment was circulated in October 1962, shortly after the move into the new building. A follow-up questionnaire to a sample of the total staff was circulated in August 1963, with the object of seeing what changes in attitude had occurred in the intervening ten months.[25]

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[21] In October 1962

[22] See appendix 10.1 for the first questionnaire

[23] This study was in progress while this report was being prepared. See appendix 5.1

[24] For a more detailed analysis of the response to this questionnaire see: **Wells, B. W. P.:** Office design and the office worker. PhD thesis, University of Liverpool, 1964

[25] See appendix 10.2 for the second questionnaire

A comparison of the answers showed that, in most ways, the building had decreased as a subject of interest. The one significant change was in the staff's attitude to the thermal environment. Temperatures were more steady and fewer people reported unpleasant draughts, but there were more complaints of uncomfortably high temperatures and the air was thought to be less fresh.[26]

Some change of feeling could be expected for, at the time the building was occupied (and the first questionnaire circulated) it was generally agreed that the airconditioning system was working at well below its operational standard. However, it is clear that the changes in opinion were by no means entirely favourable.[27]

Overall assessment of the environment

A judgement of the success or failure of the total environment within a building necessarily takes account of all the contributors: owners, users, design team, constructors, maintenance staff – and of all the contributory factors: economic, physical, social, and psychological. At present there is no way of attaching a meaningful weighting to any of these and appraisals of the total environment can only be made on an individual basis and by comparison with other buildings. No criteria exist.

This is undoubtedly the finest office environment in which the Pilkington Research Unit has worked. It is the most thoughtful, and of all the buildings in the Survey Sample it is the best designed, best detailed, and best built. It is among the best kept, but certainly the most expensive. The CIS building is a major advance on the 'routine' office block and, without doubt, among the two or three most beautiful office buildings in the country.

As a functional working tool it is almost certainly satisfactory, but it has an additional business justification, for it is the outward and visible sign of an active and determined company: forward looking, adventurous and successful.

The building provides an excellent physical environment for the staff, incomparably better than the conditions which existed in their former building. Whether it provides a better *social* environment is more open to doubt, but only because this is not a fixed thing, and there are as yet no means of measuring it with the degree of accuracy which can be applied to space, light, heat and sound. The Unit's general impression is that, on the whole, and now that the management's initial zeal for order and discipline has relaxed, the building is a considerable success. It has attracted many more applicants for employment with the Society, and is something of which the majority of the staff are proud.

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[26] The management comments that it has agreed with the workers' union (the Guild of Insurance Officials) that the average temperature maintained within the building should be 72°F, and that this caters for the majority of the staff, who are lightly clad females. As a result, many males 'mildly complain' of the heat

[27] For a more detailed analysis of the response to this second questionnaire see: Wells, B. W. P: PhD thesis, op cit (24)

Stage Four

Appendices

Appendix 1.1
Further studies seen to be necessary

Many aspects of office design have been surveyed during this investigation and new studies have been initiated in certain fields where there was a lack of information. There is, however, much work still remaining. The following are some of the many research topics which deserve further study.

1. *Sizes of office occupancies* Determination of the frequency distribution by number of staff and/or area of office space occupied by the 'typical office occupier', including both owner-occupiers and tenants.
2. *Types of office occupancy* Examination of the types of business which use office space (perhaps by Orders of the Standard Industrial Classification [1]) to ascertain the principal uses to which office space is put.
3. *Functional requirements of office space* Study of typical clerical office functions to determine the most common patterns of use of office space. This would include consideration of the work-flow of paper, the size of working groups, the functional relationship of different clerical activities, number and frequency of visitors, etc.
4. *Planning and constructional modules* Consideration of the factors influencing the choice of planning and constructional modules to see whether it is possible to determine a rationally-based system of dimensioning for office space.
5. *The external environment* Further consideration of the effects of the external environment upon the environment within office buildings.
6. *Building components and finishes* Technical and economic codification of alternative components and finishes available, including external wall construction, windows, floor and ceiling finishes and partitions.
7. *Electric lighting* Technical, economic and subjective studies of alternative lighting installations providing different standards of quality and illumination.
8. *Heating* Technical and economic studies of alternative forms of space heating, to codify the alternatives available.
9. *Building economics* Collection of additional data respecting the capital and running costs of office space. Comparison of annual costs of major design alternatives such as 'deep-blocks' and 'slabs'.
10. *Experimental aesthetics* Experimental investigations of the aesthetic qualities of office environments.
11. *Behavioural consequences of size of office space* Investigation of differences in behaviour and working efficiency of staff working in small and large office spaces.
12. *Noise* A comparative study of the distraction caused by noise and other people in large and small offices.
13. *Stable environments* An examination of stabilised environments to see whether they reduce stimulation and create boredom or restlessness.
14. *Windowless environments* Technical, economic and psychological study of windowless environments in general.
15. *Inter-action of environmental factors: technical and economic* Consideration of effects upon one environmental factor of variations in design of other factors, eg, technical and economic consequences for a heating installation of variations in daylight factor, use of double glazing, varying illumination from electric light, etc.
16. *Inter-action of environmental factors: psychological* Examination of the degree to which one environmental factor affects the subjective experience of another.

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[1] **Central Statistical Office:** Standard Industrial Classification. HMSO. Second edition, 1958

Appendix 2.1
Schedule of separate research tasks

Subsequent to the preparatory enquiries and planning for this project, a list of separate research investigations was drawn up. This appendix schedules these investigations, explains their purpose, states what was actually achieved and describes some of the problems encountered.

Priority A (in the second column of the schedule) was intended to be applicable to the stage of the project represented by this report. Priority B was assigned to investigations which could be undertaken if the duration of the project was extended.

Ref. no.	Priority	Type of investigation	Description	Purpose of investigation	Intended method of study/investigation	Staff/consultants involved	Work done	Problems encountered
Preliminary								
1	A	Postal	Definition of numbers and characteristics of office space constructed in England and Wales since the war	To provide a basis for sampling buildings for study	By postal enquiry to all local planning authorities	Geographer	Postal enquiry to all county and county borough planning authorities asking for total amount of office space built since 1945, number of individual projects and certain other matters	40 percent of planning authorities were unable to provide the information
2	A	Field	Preliminary visits to offices in Birmingham (forerunner of visits to NE and SW of England)	(i) to enlarge Survey Sample (ii) to look for regional differences (if they exist) in design, and attitude of office staff	Visits to building owners, architects and tenants in Birmingham	Architect and other members of the Unit	None	Investigation not undertaken because of shortage of time
Planning and Structure and Building Economics								
3	A	Theoretical, possibly postal	Cost analysis (of construction costs)	To provide a basis for generalisations about relative and absolute costs of different constructional elements, particularly those affecting the environment of office buildings	(i) Examination of published cost analyses (ii) Enquiries to architects of buildings in Survey Sample	Architect Geographer	Examination of cost analyses of offices which have been published in *The Architects' Journal*	Method of presentation of cost analyses and basis of analysis tends to differ from building to building. Too few buildings in Survey Sample to provide sufficient cost data for statistical analysis

Ref. no.	Priority	Type of investigation	Description	Purpose of investigation	Intended method of study/investigation	Staff/consultants involved	Work done	Problems encountered
4	A	Theoretical, supported by postal enquiry	Studies of costs-in-use of office buildings	To provide a check upon assumptions of cost which might be used in economic comparisons of design alternatives	Elaboration and checking of information about costs of rent, rates, heating, cleaning, electricity, etc which was collected during the preliminary visits. Collection of data from building owners about costs of heating installations	Architect Geographer	None	
5	B	Theoretical	Comparative technical and economic studies of building components and finishes: (i) external wall construction (ii) windows, (iii) curtain walls (iv) floor finishes (v) ceiling finishes (vi) partitions	To codify the alternatives available to the designer	(i) Review of literature (ii) Collection and comparison of trade literature (iii) Comparison of costs	Architect Physicist Quantity surveyor	None	
6	A	Theoretical	Economics of structure	To provide a basis for generalisations about the effect of structural design upon the design and economics of office space	Review of literature, considering especially: (i) high v low buildings (ii) wide v narrow buildings (iii) alternative bay dimensions	Architect, possibly Structural engineer and Quantity surveyor	None	
7	A	Theoretical	Office buildings and fire	To provide a background of information about effects of fire considerations upon design of office space	Review of literature	Architect	Review of literature with particular reference to effect of fire considerations on office environment (omitted)	
8	B	Theoretical, possibly field	Maintenance and cleaning	To provide information about the maintenance and cleaning liabilities of office buildings for use in theoretical analyses of design alternatives	(i) Review of literature (ii) Elaboration and checking of cost data collected during preliminary visits	Architect	Review of literature	
Spatial Environment								
9	A	Field	Comparative study of use of space in clerical departments	To provide information about space requirements and utilisation and extent to which this is affected by building design	Measurement of offices in use, and comparison of space utilisation in (say) typing pools, accounts offices, etc, between different firms and different types of business (eg, chain store administration and the civil service). Consideration of structural bay dimensions, window modules, type and dimensions of desks, etc	Architect Geographer	Review of literature Study of space utilisation, desk plans, etc, in 7 modern office buildings (by T. Takano, United Nations Fellow attached to the Unit)	

Ref. no.	Priority	Type of investigation	Description	Purpose of investigation	Intended method of study/investigation	Staff/consultants involved	Work done	Problems encountered
Visual Environment								
10	A	Field	Daylight and electric light in use	To obtain information which may be used: (a) in the formulation of a rational policy for illumination design for offices, and (b) as a check upon current BRS/IES attitudes and advocacy of PSALI. Study of the feelings of office workers on the importance of windows as a source of daylight and/or as a means of contact with the outside world	Observation of use of day and electric-lighting. Measurement of daylight factors, glass transmissions, reflectivities, glare conditions, etc found in use and comparison with predicted values; measurement of daylight factors from unobstructed windows, wholly overshadowed windows and internal light wells. Measurement of illumination levels from electric lighting installations and comparison with predicted values. Consideration of condition of light fittings and measurement of improvement in illumination values resulting from cleaning the fittings. Comparison of conditions in wide and narrow office buildings. Interviews with office workers in buildings having good and bad daylighting and (if possible) buildings without daylight	Physicist Psychologist Architect	(i) Measurement of daylight factor in two buildings, one side-lit, the other top-lit (ii) Measurement of illumination from electric light in six buildings (iii) Examination of lighting maintenance practice adopted in six buildings (iv) Experimental study of total environment, including visual environment, in one building (v) Experimental studies of attitudes of office workers to their visual environment	Difficulties of daylight measurement already reported in factory study. Difficulties of siting external reference photo cells in large air-conditioned buildings with fixed glazing. Questionable value of daylight illumination measurements in office buildings in congested city centres
11	B	Theoretical	Economics of alternative lighting designs	To provide an indication of the economic effects of design decisions affecting the quality of the electric lighting	(i) Review of literature (ii) Design of alternative lighting installations for given situations and calculation of their Standard Costs	Architect Lighting engineer Quantity surveyor	None	
Thermal Environment								
12	B	Theoretical	Technical and economic study of alternative forms of space heating	To codify the alternatives available to the designer	(i) Review of literature (ii) Design of alternative heating installations for given situations and calculation of their Standard Costs	Architect Heating and ventilating engineer Quantity surveyor	None	
13	B	Theoretical	Consideration of technical and economic effects upon heating installations of variations in other design factors, eg, (i) daylight factor (ii) double glazing (iii) solar radiation (iv) illumination levels of electric lighting	To assess magnitude of such effects and, if worthwhile, to provide data or to indicate trends for consideration during design process	(i) Review of literature (ii) Design of installations for particular situations and calculations of Standard Costs	Physicist Architect Heating and ventilating engineer Quantity surveyor	None	

Ref. no.	Priority	Type of investigation	Description	Purpose of investigation	Intended method of study investigation	Staff consultants involved	Work done	Problems encountered
14	A	Field	Thermal conditions in winter	To provide information about: (i) performance of heating installations (ii) thermal requirements of office workers	(i) Measurement of thermal conditions in office buildings (horizontal and vertical temperature gradients, and calculation of comfort indices) and comparison with office workers' reactions (ii) Comparison of thermal conditions in private and open offices	Physicist	(i) Measurement of thermal conditions during winter within the offices of six organisations (five buildings) (ii) Experimental study of the total environment, including the thermal environment in one large building	
15	B	Field	Draughts, including body heat loss by radiation to cold surfaces and windows	To seek information about one of the most common causes of complaint about environmental conditions in offices	(i) Interviews (ii) Physical measurement	Physicist	Experimental study of total environment, including sensation of draughts, in one building	
16	A	Field	Thermal conditions in summer	To assess thermal conditions in offices exposed to sunshine, and to compare with external climate	(i) Summer thermal surveys, calculation of thermal comfort indices and correlation with meteorological data (ii) Comparison with office workers' reactions	Physicist Psychologist	Measurements of thermal conditions during hot days in three buildings	
Acoustic Environment								
17	A	Field	Noise within offices	To provide information about noise levels within offices	(i) Measurement of external noises, and reduction provided by building construction (ii) Measurement of noise created within offices, (typing, telephoning, etc)	Physicist	(i) Measurements of noise levels in nine buildings (ii) Experimental studies of total environment in one building, including staff response to their aural environment	
Social Environment								
18	A	Lab/field	Comparative study of the attitudes of managements, architects and clerical staff to environmental priorities and standards, (owner-occupied buildings)	To establish degree of consonance	Structured interviews, questionnaires, paired comparisons of different office layouts, attitude scales	Psychologist	Comparative study of beliefs and attitudes of office managers, supervisors, and clerical staff to the optimum size of clerical working areas	Insufficient time within the project to await suitable opportunities of studying architects' attitudes
19	A	Lab/field	Social relationships within different sizes of office space	To provide data of social, psychological and management interest on the influence of spatial relationships	Sociometry	Psychologist	Study of socio-preferential links within and between sections sharing very large areas and those in separate ones	

Appendix 3.1
Construction costs of office buildings

Although the economics of a particular building project must eventually be based on the *annual* costs, a matter of immediate concern will be the possible level of construction costs. *The Architects' Journal* has published a number of cost analyses of office buildings, and a simplification of these is given in table 8.

Table 8
Cost analysis of 13 office buildings, abstracted from cost analyses published in *The Architects' Journal.*

Grouped Elements	Cost in shillings/sq.ft (normalised to November 1963)			Percent of total cost		
	Mean	Min.	Max.	Mean	Min.	Max.
Preliminaries, insurance, contingencies	6.5	1.4	11.7	7.3	1.6	11.9
Work below ground floor level, drainage	6.7	2.8	11.8	7.1	2.5	9.9
Structural frame, structural upper floors, roof, staircases	21.2	13.4	38.2	22.5	14.3	34.9
External walls, windows, doors	18.5	10.3	31.1	19.7	14.3	27.0
Internal doors, screens and partitions, internal finishes	19.7	13.3	33.8	20.9	13.0	29.7
Heating and ventilating installation	9.9	4.7	21.2	10.6	4.2	20.9
Electrical installation for light and power	5.2	1.8	8.8	5.3	2.7	8.1
Other services, lifts, etc.	6.3	1.9	16.5	6.5	2.1	13.3
Total Cost	93.8	62.3	123.8			

No. of buildings in sample = 13

Appendix 4.1
Schedule of post-war office space approved, built and under construction in the areas of certain local planning authorities

(Information available at October 1964)

London and Metropolitan Counties

Floor areas in sq.ft to nearest 100 sq.ft.

County and Location	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Essex (metropolitan parts)	Not available	Not available	Not available	791,600	1955 to 1960 Floor space approved in new buildings, rebuildings and extensions (excluding all outline applications and ancillary offices less than 5,000 sq.ft)
Hertfordshire (central, west, east and north)	Not available	Not available	Not available	507,700	1958 to 1960 All new buildings approved
Kent (west of and including the Medway towns, Malling RD, Maidstone B and RD, Tonbridge UD and Tunbridge Wells)	Not available	Not available	Not available	995,600	1955 to 1960 Permission for offices (including major changes of use) local offices, sub-regional offices and offices over 5,000 sq.ft for industry
London – central	35,549,300	11,295,300	7,862,300	54,706,900	1948 to 1961 New buildings, rebuildings and extensions
London – rest of county	2,085,300	1,751,100	816,400	4,652,800	1955 to 1961 New buildings, rebuildings and extensions.
Middlesex	6,363,700	2,633,500	5,423,700	14,420,900	1955 to 1963 All approved schemes over 5,000 sq.ft
Surrey	Not available	Not available	Not available	3,021,100	Mid 1957 to Mid 1962 Approvals

Larger County Boroughs (population greater than 200,000 in 1961)

County Borough	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Birmingham	2,250,000	1,152,300	350,000	3,752,300	1951 to 1962, central area, major projects
Liverpool	1,584,000	587,500	Not available	2,171,500	1951 to 1962, central area, all projects
Manchester	1,876,800	Not available	Not available	1,876,800	Post-war, central area, major projects
Sheffield	265,300	159,900	Not available	418,200	1956 to Sept 1962, central area, major projects
Leeds	600,000	Not available	Not available	600,000	1948 to 1962, central area, major projects
Bristol	1,879,500	280,000	1,003,200	3,162,700	Post-war to end 1963, central area, all projects
Nottingham	170,300	177,900	313,500	661,700	Post-war, whole area, all projects
Kingston-upon-Hull	130,600	Not available	Not available	130,600	1948 to 1960, central area, all projects
Bradford	281,000	Not available	Not available	281,000	Post-war, whole area, all projects
Newcastle-upon-Tyne	est. 250,000	In 'built'	Not available	250,000	1949 to 1961, central area, all projects
Leicester	216,600	In 'built'	106,000	322,600	1950 to 1962, whole area, major projects.
Stoke-on-Trent	52,400	44,200	70,000	166,600	Post-war, central area, major projects
Coventry	173,000	124,000	Not available	297,000	Post-war, whole area, major projects
Croydon	1,238,900	1,647,200	3,772,900	6,659,000	Post-war to end 1963, whole area, major projects
Cardiff	807,500	Not available	Not available	807,500	1956 to 1962, whole area, all projects
Portsmouth	Not available	67,000	200,000	267,000	Post-war, central area, major projects
Plymouth	378,800	Not available	30,300	409,100	Post-war, central area, all projects
Southampton	247,400	Not available	Not available	247,400	1957 to 1962, whole area, all projects

Smaller County Boroughs (population less than 200,000 in 1961)

County Borough	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Barnsley	64,500	Not available	Not available	64,500	1946 to 1962, whole area, all projects
Barrow-in-Furness	Not available	105,000	Not available	105,000	Two office blocks only
Bath	77,400	Not available	Not available	77,400	1946 to 1962, five office blocks only
Birkenhead					Two office blocks only, no details
Blackburn	3,100	83,600	51,000	137,700	1948 to 1962, whole area, all projects
Blackpool					Very little new office building
Bolton					Very little purpose built office space except in connection with industrial development
Bootle	64,000	Nil	155,000	219,000	Post-war, four projects
Brighton	239,400	50,600	187,700	477,700	1946 to 1963, major projects
Burnley					No purpose-built office space except in connection with industrial development
Burton-on-Trent	60,800	Not available	Not available	60,800	1946 to 1962, whole area, all projects
Bury	Not available	Not available	Not available	141,800	1947 to 1962, permissions
Derby	538,900	Not available	Not available	538,900	Post-war, three major office buildings
Dewsbury	34,700	78,900	12,400	126,000	1947 to 1962, whole area, all projects
Doncaster	158,700	10,400	280,500	449,600	1949 to 1962, whole area, all projects
Eastbourne	50,000	26,500	Not available	76,500	Two office blocks only, very little new office building
East Ham					Very little office building
Gateshead	14,400	Nil	24,200	38,600	Post-war, central area, major projects
Halifax	65,900	Not available	Not available	65,900	Post-war, major projects
Ipswich	143,100	Not available	Nil	143,100	1948 to 1962, central area, major projects
Middlesbrough	129,200	Not available	Not available	129,200	1955 to 1962, major projects

Smaller County Boroughs (continued)

County Borough	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Northampton	77,700	25,100	Not available	102,800	1951 to 1962, major projects
Norwich	106,000	8,000	19,200	133,200	1952 to 1962, some major projects
Oldham	64,100	49,400	16,000	129,500	1945 to 1962, central area, major projects
Oxford	est. 200,000	Not available	80,000	280,000	Post-war, not more than this figure
Reading	595,800	In 'built'	369,100	964,900	Post-war, whole area, major projects
Rochdale					One office block only, no details
Rotherham	202,400	32,800	1,600	236,800	1946 to 1962, whole area, major projects
Salford	Nil	61,800	Nil	61,800	One office block only in post-war period
Smethwick	126,400	31,200	137,000	294,600	1948 to 1960, whole area, all projects
Southend	376,500	202,400	232,000	810,900	1955 to 1962, whole area, major projects.
Southport	23,100	Nil	28,000	51,100	Three office blocks only, central area
South Shields	43,500	Nil	5,200	48,700	1954 to 1962, whole area, major projects
Stockport	32,200	48,000	Not available	80,200	1948 to 1962, central area, major projects
Tynemouth	7,000	Not available	30,200	37,200	Two office blocks only
Wakefield	155,100	5,400	Nil	160,500	1945 to 1962
Wallasey					No new office space built.
Walsall	139,500	34,000	133,000	306,500	1955 to 1962, central area, major projects
Warrington	129,000	Not available	Not available	129,000	1948 to 1962, whole area, all projects
West Bromwich	84,700	Nil	Nil	84,700	Post-war, three projects
West Ham	Not available	Not available	Not available	406,700	1955 to 1961, approvals greater than 5,000 sq.ft
West Hartlepool	17,600	Nil	30,000	47,600	Post-war, central area
Wolverhampton	est. 200,000	60,000	Not available	260,000	Post-war, central area
Yarmouth	Nil	Nil	25,000	25,000	No office blocks erected, one block approved
York	154,000	In 'built'	47,000	201,000	Post-war
Newport	Not available	Not available	204,000	204,000	1949 to 1962, no details of offices built

Other County Councils

County Council	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Bedfordshire	160,600	85,400	38,900	284,900	1949 to 1962, details for Luton and Bedford only
Berkshire	Not available	Not available	Not available	526,900	1955 to 1961, planning consents in ten local authority areas
Buckinghamshire	Not available	Not available	Not available	1,117,200	1955 to 1960, permissions (including major change of use) greater than 5,000 sq.ft in central and southern parts of county
Cheshire	Not available	Not available	Not available	948,900	1948 to 1962
Cornwall					Seven major projects, no details
Isle of Ely	5,200	Nil	3,500	8,700	Three office blocks only
Gloucestershire					Very little new office space except in connection with industrial development
Kesteven					Very little office building
Somerset					Three projects under construction, 32 approved, not started yet. No details
Staffordshire	828,900	44,700	257,600	1,131,200	1947 to 1962, *incomplete* information from ten local authority areas
Suffolk East					Very little office building
Suffolk West	Not available	Not available	Not available	143,000	Five office projects approved since 1961, plus office space in connection with industrial development
Sussex West	68,900	158,000	31,600	258,500	*Incomplete* list of major post-war office blocks in four local authority areas
Westmorland	46,200	3,500	Nil	49,700	1957 to 1962, six office blocks only in town centre of Kendal
Yorkshire E.R.	Not available	Not available	Not available	100,200	1948 to 1962, permissions in Haltenprice and areas adjacent to Kingston-upon-Hull

Other County Councils (continued)

County Council	Built	Under construction	Approved not yet started	Total approved (minimum estimate)	Qualifying remarks
Yorkshire N.R.					One large building, other development over new shops
Yorkshire W.R.					Very little new office space except in connection with industrial development
Anglesey	40,400	3,800	5,700	49,900	1947 to 1962
Cardiganshire	20,700	Nil	35,500	56,200	Three office blocks built and another approved
Flintshire	40,900	700	12,600	54,200	Post-war, in four district councils
Merionethshire	11,300	18,200	Nil	29,500	Three office blocks built, one under construction
Monmouthshire	Not available	Not available	Not available	572,500	1945 to 1962, approvals
Montgomeryshire	21,000	Nil	Nil	21,000	Post-war, four office projects only
Pembrokeshire					Six projects only, no details
Radnorshire					Very little office building
New Towns					
Basildon	38,400	38,800	Not available	77,200	To December 1962
Bracknell	254,300	None	Not available	254,300	To December 1962
Crawley	197,900	None	Not available	197,900	To December 1962
Harlow	160,600	58,300	Not available	218,900	To December 1962
Hatfield	3,000	15,000	Not available	18,000	To December 1962
Hemel Hempstead	184,400	180,000	Not available	364,400	To December 1962
Stevenage	139,300	None	Not available	139,300	To December 1962
Welwyn Garden City	121,800	None	Not available	121,800	To December 1962
Corby	40,100	1,700	Not available	41,800	To December 1962
Cwmbran	26,200	None	Not available	26,200	To December 1962
Newton Aycliffe	12,500	None	Not available	12,500	To December 1962
Peterlee	8,400	15,000	Not available	23,400	To December 1962

Appendix 5.1

The influence of office size on the individual and on supervisory and managerial processes

Summary

On Tuesday 26th May 1964, the experimenter conducted meetings with four consecutive groups of clerks which totalled nearly three hundred individuals, and represented the whole population of one of the podium floors in the new CIS building. Using a recorded talk and instructions, together with slides and questionnaire-type reply forms, attitudes towards the open plan office were probed and sociometric data gathered.

In the afternoon of the same day, a group of supervisors and managers was seen collectively and data concerning the attitudes of the individual members of the group towards, and professional feeling about, open planning were obtained with the aid of paired-comparison slides and a questionnaire.

A number of hypotheses concerning user attitudes to open planning, and its social consequences were formally tested. These findings, together with the organisational requirements stated by supervisors and managers, were drawn together to demonstrate the human factors involved in optimizing the internal layout of office buildings. The conclusions drawn from the three sources of clerks, supervisors, and managers are summarized separately at the end of this appendix.

Statement of purpose

The purpose of this appendix is to establish the influence of room size on the personal satisfaction of the users, and to appraise the relative benefit of open plan versus small office arrangements for supervisors and managers. The degree to which social interactions are determined by spatial relationships is examined, and their effects upon working efficiency and job satisfaction discussed.

Form of the appendix

This appendix is composed of three relatively discrete parts, each of which is presented as a separate research report. However, the summary of background theory and research has been dealt with and presented at the beginning as each of the parts relates to the common type of attitudes towards, and the influence of, open office areas.

Part One describes an investigation conducted with general clerical workers and the results obtained. Parts Two and Three describe investigations conducted with supervisors and managers respectively, and the results obtained from them. Part Three is followed by 'Conclusions', in which the main findings of each part are drawn together and discussed, and the general conclusions stated.

Background of theory and research

The findings of the study of clerical workers subjective response to lighting[1] indicated that it may well be possible to build environmentally satisfactory offices at much greater depths than has previously been supposed. However, the possibility of deeper buildings was qualified by the probable importance of there being an unobstructed view of windows, which suggests that in order to get the possible advantage of deep buildings, it may also be necessary to accept open working areas. However, size of office area is potentially a factor determining the formation and interaction of groups, and is therefore a question of considerable importance to both employees and managers. The question of whether given office sizes constitute pleasant and acceptable work places will also influence the design policy. Therefore, both objective and subjective response patterns must be studied in relation to any investigation of the optimum size of office spaces.

Question 19 of the first CIS questionnaire[2] asked the staff of the CIS to state their preference for the open or the smaller office. Differences in the response pattern of the sub-groups were found but the results indicate a very widely held preference for smaller offices or partitioned areas. However, the question of office size, impinging as it does on management, supervisory and building economic considerations, as well as the individual and social psychological ones of the users, is too important to be settled by what amounts to a referendum on the preferences of the clerks. Certainly, the needs and attitudes expressed by the choices are important, but their importance will be relative to the other considerations involved in office layout.

A multiplicity of small office spaces is still, as it has been in the past, normal practice. However, in the last few years, an increasing number of arguments has been advanced in favour of the open plan office. The most persuasive of these are in terms of building economics and flexibility of use; the least persuasive refer to the needs, satisfactions, attitudes and working efficiency of the users. (The latter type of argument lacks the empirical evidence usually produced in support of the former).

If the arguments for deep block construction and open office space were dependent for their success upon arguments based on organization and costs, then there is little doubt that they would rapidly gain acceptance. But it is generally the arguments for small working areas, based on human requirements and management considerations, which prevail. These tend to be polemical rather than rational; their success being due to conservatism in the form of preferring the familiar to the unfamiliar, and because architects and managers are prone

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1. See chapter 6
2. See chapter 10 and appendix 10.1, Supplement 8

to taking as their frame of reference how they themselves would react to certain conditions.

The literature on the open plan design is replete with comment which, in the absence of good supportive evidence, can only be taken as an attempt at identification with the clerical worker. The very terms used in stating the problem are heavily weighted with the attitudes of their authors. In an address to the Association of Industrial Medical Officers, McGirr,[3] referring to open plan offices, spoke of 'herding clerical staff into them' and described them as 'soulless subtopia of impersonalization'. He rejected the counter-evidence of their acceptance in America on the grounds that open planning is congruent with the American national aim of 'togetherness', whereas it is a 'principle fundamentally at variance with our national concepts of individuality and personal privacy, and with a healthy yearning for nonconformity'.

McGirr's position has clearly been derived from reference to his own standards. His beliefs in the need for individuality and personal privacy are middle class sentiments which are not necessarily relevant to the majority of workers in the large clerical organizations. As Lockwood[4] has pointed out, recent social and economic forces have created paperwork industries manned not by the non-professional members of the middle classes, but mainly by members of lower socio-economic groups. The nature of the work is also different: it has been mechanized and de-skilled and is now largely in the hands of young female workers. It has currently more in common with light industrial assembly work than with the clerical work of a generation ago. It may very well be, then, that the sentiments expressed by McGirr are not those of the modern office worker, but only research will settle the issue.

Unfortunately, the research is not done before the conclusions are presented. Even such respected figures as McGirr (who was a member of the Institute of Directors' main committee in the publication of 'Better Offices'), reach far beyond the evidence when discussing open office planning. In the paper referred to above, he went on to say:

> '. . . by neglecting the social studies already existing in small group performances, these gentlemen (ie, methods engineers and business efficiency experts), may be sowing the seeds of future frustration and breakdown. I believe that as doctors in commerce and industry we have a duty to protect those entrusted to our care against the potential evils of an entirely mechanistic approach by work study'.

This, of course, constitutes a clarion call to industrial medical officers to oppose innovation on exceedingly slender evidence and grounds. Almost nothing is known of the consequences of open plan organisation and it is premature to support that it may be the cause of future frustration and breakdown. However, although the chain of evidence is not a strong one, and is probably coloured by personal feelings, one certainly cannot disregard McGirr's apprehensions; indeed they are shared by many planners, managements, and their staffs.

McGirr concluded his paper by saying:

> 'We must make ourselves familiar with studies in group dynamics and breakdown; if satisfied that the human element is being neglected for a wholly mechanical approach to work, we ought to be fearless in our denunciations'.

This is, of course, a sentiment with which few people would disagree, but the links connecting human happiness and psychic balance with space utilization and staff deployment have yet to be shown. The whole question is so important from not only a personal point of view, but also from those of management and designers, that research into the subject is clearly necessary.

The question of the influence of space on the individual and on his social and occupational relationships is one which has received surprisingly little attention in view of the great attention devoted to almost all other aspects of environmental conditions. Where such studies have been made, they have been variously described as studies of 'group geography',[5] 'psychological geography',[6] 'microecology',[7] and 'spatial ecology'.[8] This latter term seems particularly apt in the context of studies in which the influence of distance and physical barriers between individuals and groups is the ecological aspect emphasised. It will therefore be used with these connotations throughout the rest of the appendix.

Perhaps the most celebrated attempt to apply the methods of social psychology to the question of the effect of building design on the individual was that of Festinger and others.[9] They studied the effects of spatial ecology on group formation in various types of housing, and concluded that:

> 'the relationship between ecological and sociometric structures is so very marked that there can be little doubt that in these communities passive contacts are a major determinant of friendship and group formation'.

Similarly, Gullahorn[10] showed in an office setting that frequency of social interaction and socio-preferential choice were closely related to spatial relationships. This raises the question of whether, in an organization like the CIS where departments are broken into smaller sections working side by side, informal groups arise more easily between individuals assigned to different formal groupings. This present study will contrast some of the friendship patterns found in open working areas with those of some relatively small and enclosed areas.

In view of the research findings on spatial ecology referred to above, one might expect there to be a number of important managerial consequences arising from the decision to adopt either the open or the closed office plan. One might expect, for example, that the single section occupying a small office would offer the greatest opportunity for the formation of a stable work group. In such surroundings, cohesive forces would derive from the fact that each member of the primary (or face-to-face) group shares the common working objectives of that group. The small office area produces a closeness of the group determined not only by the physical distances between working spaces, but also by functional distances involved. That is, people are brought closer together by the passive interactions taking place as a result of using a common entrance and common circulation space, and also by the non-business interactions at such foci as the filing cabinets, postal trays, and telephones. Unlike the open office, all these interactions will take place on an intra-group basis. Thus the small office arrangement produces the best possibility for the formation of a group with a clear identity and concept of itself as a discrete and simple entity.

The open plan office allows for more possibilities of inter-personal contact and group formation. Common entrances and circulation spaces will increase the number of inter-group contacts. Without partitions, both the physical and functional distance between groups is reduced and one might expect, from the research findings referred to above, that the number of inter-group

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3. **McGirr, P. O. M**: Environmental targets in offices and commercial premises. Trans Assoc Indust Med Offrs. 1959, **9** (3)
4. **Lockwood, D**: The black-coated worker. Allen and Unwin, 1958
5. **Sommer, R**: Leadership and group geography. Sociometry, 1961, **24** 99-110
6. **Moreno, J. L**: Who shall survive? A new approach to the problem of human inter-relations. Nervous and Mental Disease Monograph Series no. 58. Washington, 1934
7. **Sommer, R**: Studies in personal space. Sociometry, 1959, **22** 247-260
8. **Festinger, L., Schachter, S.,** and **Back, K**: Social pressures in informal groups. A study of human factors in housing. Tavistock Publications, 1963. First Published in USA in 1950. Second edition 1963: Stanford,Calif: Stanford UP
9. **Festinger, L., Schachter, S.,** and **Back, K**: op cit (8)
10. **Gullahorn, J. T**: Distance and friendship as factors in the gross interaction matrix. (In the Sociometry Reader, ed: **Moreno, J. L.** Glencoe: Free Press, 1960)

friendships would increase. The individual may then find himself a member of two groups – the formal group of his section, and an informal friendship group composed of members of different sections.

The existence of large numbers of intra-group friendships (ie, within the formal work unit), is a factor which has been shown to be related to group effectiveness and morale.[11, 12] Unlike the small office, the open plan area allows for the easy formation of inter-group friendships. If these are made at the expense of the intra-group ones, then one might expect on theoretical grounds that the morale and effectiveness of the work unit might suffer.

The proliferation of friendship groups between work units is also a potential force working against managerial control. The status roles, lines of communication, and group loyalties intended to operate within a working group may well be undermined by the competing claims of the informal group. The influences exerted by the immediate primary group can be very strong indeed, influencing the attitudes, expectations, and behaviour of not only the pliable individual, but also the average and strong personality.[13,14,15,16] An appraisal of these effects is therefore a prerequisite to the management decision of whether to adopt the open plan: whether the advantages are outweighed by the disadvantages. An approach to this question will be made in this appendix.

As the preceding discussion has shown, the question of the acceptability of the open plan office depends upon a multiplicity of considerations and viewpoints, some of which are amenable to psychological analysis. First of all there are the feelings and attitudes of the users; secondly there are the social and organizational consequences of the different spatial arrangements. Finally, there are the requirements of supervisors and managers. Each of these aspects has been investigated and the results described in this appendix.

PART ONE: GENERAL CLERICAL WORKERS

Hypotheses to be tested

The investigation of office space reported in this appendix is predominantly heuristic, and to a lesser extent theory-derived. Consequently the number of hypotheses to be tested is kept to a minimum. However, a number of specific propositions are suggested by the results of the research so far, and by existing theory on spatial ecology.

The hypotheses may be categorized as being of two basic types. The first concerns staff attitudes towards large working areas; the second concerns the social and therefore the organizational consequences of providing either large or small working areas.

The findings of the first CIS questionnaire study[17] revealed a good deal of general support for the smaller office area and further analysis of the results suggested that attitude to office size might be related to the size of office in which the respondent was working. It is now proposed to test rigorously the hypotheses that they suggest.

The hypotheses relating to staff attitudes to large working areas may be stated formally as follows:

Hypothesis 1 The smaller working area will generally be preferred to the larger.

Hypothesis 2 People working in large open areas will be relatively better disposed towards large areas than those who work in smaller areas.

The theoretically expected consequences of open office planning have been referred to at length in the discussion of background theory and research. The influence of proximity on friendship formation has been discussed generally and the hypotheses constitute three expected derivations of the effect. They may be stated formally as follows:

Hypothesis 3 The number of friendship choices made and received between people will be progressively fewer with increased distance.

Hypothesis 4 The number of inter-section preferences expressed will be greater in the open areas than in the smaller semi-partitioned ones.

Hypothesis 5 There will be a higher proportion of reciprocal choices in the smaller work areas than in the larger ones, though a greater number of isolates.

One further hypothesis will be proposed for which the results concerning space preferences expressed in the three parts of this appendix will be compared and contrasted. One would not expect that the attitudes and requirements of clerks, supervisors and managers would necessarily coincide, and so the following hypothesis is proposed:

Hypothesis 6 There will be a marked difference between the attitudes of clerks, supervisors and managers to open office planning.

This last hypothesis cannot, of course, be tested within the context of this part of the appendix only. It will therefore be examined, in the context of the findings of all three parts, in the conclusions at the end of the appendix.

Population and samples used

The sample used was dependent primarily upon location. The nature of the investigation demanded that there should be very large working areas, with some smaller areas screened-off. This inevitably meant that the population from which the sample could be drawn must be on one of the podium floors. As, for experimental reasons, the sample had to be extended to an entire floor, one was sought where there was considerable homogeneity amongst the work groups. This would exclude floors having typing pools or machine rooms on them.

Only one floor adequately met the experimental requirements and it was therefore selected. Three small areas were then picked out for special attention as being fairly well defined from the surrounding areas. They serve as the 'small areas' to be contrasted with the remainder, or 'open areas', in the rest of this appendix. Each of the small areas was enclosed on three sides by a window wall and two internal walls: each working section faced the window wall and had the opening to the larger office behind it.

Each of the three small areas houses one single section, and a previous survey showed that the nature of their work and their working interactions with other sections, were in no way different from any other section composing the three departments on this floor. In fact, though the three departments have partition screens between them, and have separate managers, they are nevertheless all parts of a larger department and there is therefore considerable similarity between the work and method of organisation in each.

All of the people working on the floor chosen were invited to participate in the study and, with the exception of those away sick or on holiday, all did. They composed 295 general clerks in the grades below section clerk (ie, supervisor). The sample was therefore fairly homogeneous as it did not include any other such categories as machine operators, typists, managers or supervisors.

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[11] **Goodacre, D. M**: Group characteristics of good and poor performing combat units. Sociometry, 1953, **16** 168-178

[12] **Horwitz, M.** and **Cartwright, D**: A projective method for diagnosis of group properties. Human Relations, 1953, (6) 397-410

[13] **Sherif, M**: A study of some social factors in perception. Arch Psychol. 1935, **27** 187

[14] **Sherif, M**: The psychology of social norms. Harper, New York, 1936

[15] **Asch, S. E**: Effects of group pressure upon the modification and distortion of judgements. (In: Readings in Social Psychology, Ed. **Maccaby, E. E., Newcomb, T. M.** and **Hartley, E. L.** Methuen, 1959)

[16] **Roethlisberger, F. J.** and **Dickson, W. J**: Management and the worker: an account of a research programme conducted by the Western Electric Company, Hawthorne Works, Chicago. Harvard University Press, Cambridge (Mass), 1939

[17] See chapter 10

Of the 295 respondents, 214 worked in the large open areas, and 81 in the smaller enclosed areas referred to above. The age and sex composition of the groups working in the two types of area was as follows: the youngest age group of 15 to 19 year olds composed 43 percent of the population, and older workers, the age groups over 40, accounted for 21 percent. The age groups between 20 and 39 were fairly evenly distributed minorities. The ratio of females to males was of the order 2 to 1. These proportions are closely similar to the distributions for the staff as a whole.[18]

Method of investigation

It was decided at the outset that the best way of collecting the sort of highly personal data asked for by this section of the investigation would be a group administered questionnaire. In this way, though people would be drawn together in large numbers, they could be drawn not as groups but as aggregates, giving essentially isolated conditions for the individual, but having the advantage of processing large numbers at one time. The experimenter could think of no alternative that would have been as satisfactory in preventing discussion between the individuals, and keeping the replies within a very restricted period of time.

Any such group investigation needs the complete support and co-operation of management. The first approach was to the general manager who accepted in principle the need for the method, and therefore for the partial disruption of departments. He was, moreover, kind enough to advocate the matter with the departmental managers concerned. The three managers involved were most understanding, and together with their chief clerks planned the time and the arrangements with the experimenter. The date decided upon was Tuesday 26th May 1964 during the morning. In order that the sessions should be completed before lunchtime, when it was feared that confidences and notes might be exchanged, the first session was set at nine o'clock in the morning – half an hour after the commencement of work – and the half hour between 10 and 10.30 a.m. was left open for coffee. Each session was scheduled to take half an hour and there were therefore to be four sessions each of which would involve one quarter of the personnel in each department. The chief clerks and supervisors took the responsibility for making up the groups, which was to be dictated by the exigencies of work rather than any other factors.

As large numbers of staff were involved, a fairly large room was needed to accommodate them. To this end the recreation (coffee) room was kindly put at the experimenter's disposal. As the subjects arrived for the sessions they were mixed up as much as possible in the seating arrangement by assigning them alternately to the two sides of the room. On each seat was placed a ball point pen, a stapled set of questionnaire reply forms and an explanatory letter (Supplement 1).

In order that the programme should run to the strict time limits set, and so that the research material for each of the four sessions should be presented in exactly the same form, a tape recording and a magazine of slides was used. A slide was being projected on the screen for the whole of each session, the first carrying a title, the last thanking people for their participation, and in this way a focus of attention was maintained during the entire session.

After allowing a minute or two for people to settle down and read the introductory letter, the recorder was started and the following introductory message given:

> 'You are probably very surprised to be addressed by a tape recorder rather than directly from the platform but there are very good reasons for this.
>
> The first reason is connected with the experimental procedure, that is, being sure that everyone is presented with exactly the same situation, and given precisely the same amount of time and explanation. This would be virtually impossible to achieve on each of many occasions that this has to be done.
>
> The second reason arises because, in order to undertake such a very large survey involving so many people, one has to work to very strict timings to ensure that individuals and departments are not put to a great deal of inconvenience.
>
> I hope that the initial shock is now over and that you will feel inclined to sit back, enjoy a cigarette, and relax.
>
> You will all have had time to read my covering letter with the questionnaire, but I should just like to underline the fact that the information being gathered is not on behalf of either the Management or the Guild, though both these bodies support the study.
>
> At several points in the questionnaire it has been

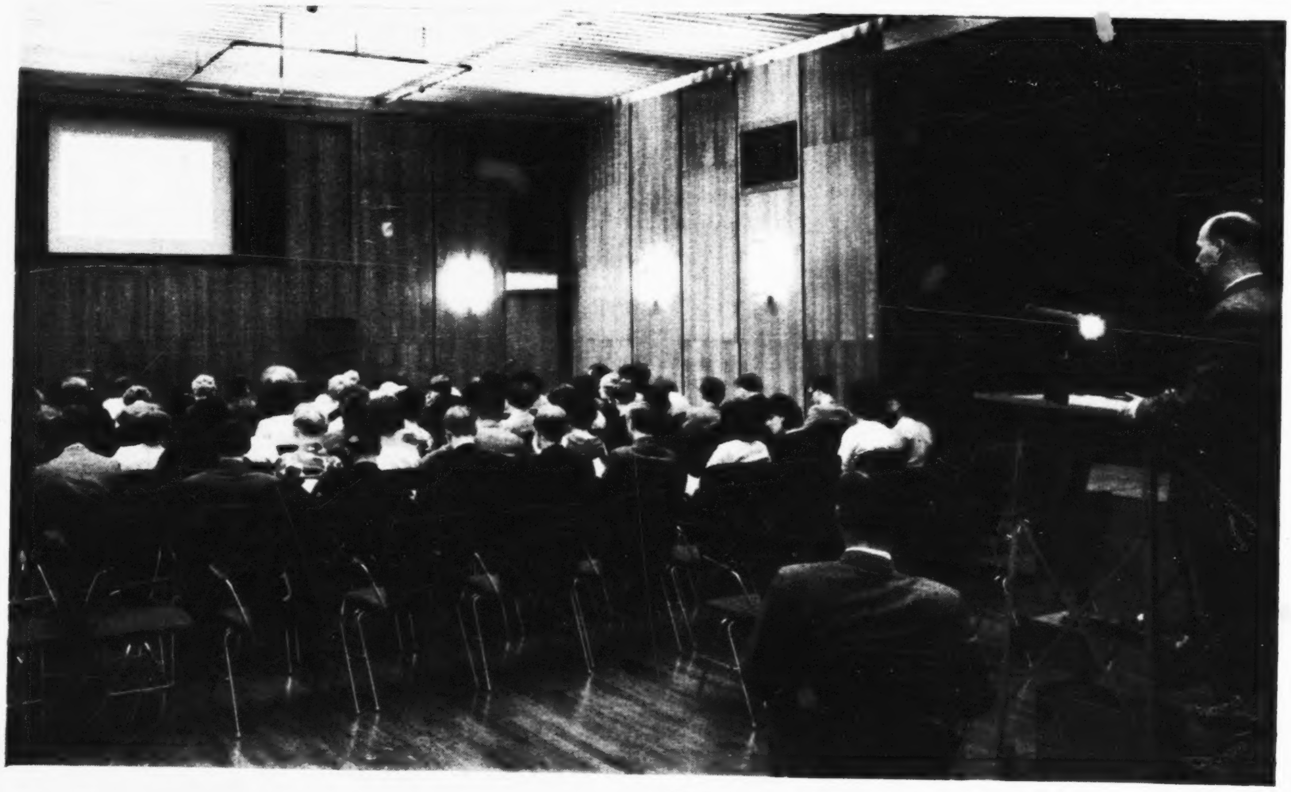

Figure 92
Group administered questionnaire.

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[18] **Wells, B. W. P:** Office design and the office worker. Ph D thesis, University of Liverpool, 1964

> stressed that any information given will be treated confidentially. This questionnaire, unlike previous ones, asks for names and a good deal more personal data. Some of this might appear to be an intrusion into your personal affairs and be none of our business. This is a perfectly fair point of view, but in support of our request may I make two brief points: the first is that the data can be generalised and is badly needed to guide the designers of office buildings, and one hopes that the lessons learned would be used to the advantage of members of your profession in the future. The second is to underline the fact that personal privacy will be *absolutely* maintained.
>
> Whether you are prepared to help us by completing the questionnaire is, of course, entirely for you to decide, but we hope that you *will* be kind enough to do so. However, if you do have any reservations perhaps you would be kind enough to complete the document just the same and let me know about them before you leave. If, after explanation, your reservations still persist, then you could feel free to destroy the document before leaving.
>
> I am quite sure that the practical purpose of this questionnaire, like the others you have been kind enough to reply to, must seem very unclear. And I must apologise for not being more lucid on this occasion, but it is very nearly impossible to be specific about one's own special beliefs and interests without influencing other people's. However, this programme is now virtually at an end and it will then be possible to explain the objectives in detail, perhaps in the form of an article in *The Review.*[19] I hope then that you too will feel that you have participated in a thoroughly worthwhile project.
>
> Thank you for your attention so far, now to turn to the questionnaire itself.
>
> Where detailed instructions are given I will read them through to make sure that no one falls behind and that the whole group moves at the same speed.
>
> *Part One*
>
> As you see, the first part of the questionnaire is devoted to your personal details.
>
> Please write your initials and surname in the blank space provided, then put a tick in the appropriate box for your sex, grade and age group.
>
> The final piece of information required is your department and the name of your section clerk'.

The instructions, written at the head of each reply section, were then read for each reply section. The recording, allowing times for the respondents to answer the questions, took exactly 20 minutes. The final item of the recording was:

> 'That then is the end of the questionnaire. Will you be kind enough to hand it to me personally as you make your way out. Once more, very many thanks for having taken part'.

The respondents then left the hall, passing as they did so the experimenter who was waiting at the door with an assistant to collect the completed questionnaire forms and answer any queries.

Items forming the study: their rationale, construction and results

Although the data for this study was collected on a questionnaire-type reply form, it is not a true questionnaire study at all. Rather it is a portmanteau collection of an attitude scale, a sociometric record form and a record form for independently presented pictorial material.

Because of the diversity of the items composing the study, the most convenient and coherent way of describing them and their results is to deal with them individually in the order in which they appear in the original reply form.[20] In the form itself each item is referred to as a numbered 'Part'. However, as this term has also been used to refer to the three separate studies comprising this appendix, the term 'Item' will be substituted in the following discussion.

Each item is presented under the three headings of 'Rationale and construction of the instrument', 'Form of analysis of data', and 'Results and discussion of results'. The conclusions to be drawn from the results of each item, and their implications for the hypotheses being tested, have been deferred to the separate 'Conclusions' section at the end of the appendix.

Item One

Item One requires no special explanation, dealing as it does with personal details and matters of fact. The information collected serves the threefold function of providing the demographic data about the sample, specifying the age, sex, grade and working section of the respondent so that they can be related to the form of the replies, and finally to indentifying the respondent for the analysis stage of the sociometric study.

Item Two – Attitude Scale

Rationale and construction of the instrument

This item consists of a scale for the measurement of attitudes towards the open plan office. A form of measurement was sought which would allow numerical comparisons to be made between individuals and between groups. The method chosen to construct the attitude scale was the method of paired comparisons for complete data which is described in detail by Edwards.[21]

The use of paired comparisons to construct an attitude scale is analogous to the method used for ranking physical objects in the absence of a physical scale. In such a situation the most accurate method is to compare all possible pairs of the objects to be ranked and then to make the single judgement of which of the two is of the greater magnitude on a given criterion. The accuracy of the method is further increased by using a large number of judges and obtaining average judgements. Attitudes may also be ranked and assigned a position on a scale by a similar procedure.

The first step in preparing such a scale is to collect a number of statements representing attitudes either positive or negative towards a given psychological object. In the present instance some 30 statements were collected together, all of which represented attitudes conveying some degree of favourableness or unfavourableness towards the open plan office. These came either from the records of interviews with members of the CIS, or were a distillation of attitudes expressed at other times.

The next step was to weed out those statements which were too similar in content, those which were not completely relevant, those which were factual or likely to be interpreted as factual, and those which contained more than one single thought.

Application of these criteria reduced the number of suitable statements down to twelve. They were then paired in all combinations and orders and presented to collaborators who were asked to choose from each combination the one which they felt to be most favourable towards the larger office area. At this stage four statements were dropped from the scale as not being clearly enough discriminated from other statements.

The remaining eight statements were then re-assembled in paired-comparison form and presented to a new set of judges. The judges at this stage and subsequently were university personnel comprising teachers, students and research students who knew nothing of this project, and were not in any way concerned with office work or the planning of office space.

A spot check of the results was made after twenty-five judges had made their judgements. From this it was evident that the eight statements were being sufficiently well discriminated to continue. In all, 64 subjects acted as judges.

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[19] The CIS staff magazine

[20] See Supplement 2

[21] **Edwards, A. L:** Techniques of attitude scale construction. Appleton – Century – Crofts. New York, 1957

An internal consistency check revealed that the judgements made by the 64 judges were indeed quite consistent, and that the scale values were therefore derived from reliable data. A test of significance and unidimensionality showed that assumptions of additivity and unidimensionality along a psychological continuum were justifiable in the present case.[22]

The final order of the statements, as ranked by the judges, is given in table 9 together with the calculated scale values. Their order of presentation in the questionnaire was randomised, and this order is shown in the last column of the table.

Table 9

Rank order of the statements forming the attitude scale

Scale value	Pos or Neg	Judged rank	Statements	Order in questionnaire
0	Neg	1	There is an uncomfortable feeling of being watched all the time in a large office	6
0.43	Neg	2	The larger offices make one feel relatively unimportant	2
0.80	Neg	3	The large office creates less feeling of permanence and security than a small one	5
1.13	Neutral	4	The size of the office itself is not really important	4
1.29	Pos	5	Any disadvantages of the larger office are offset by greater advantages	8
1.45	Pos	6	The social life of a large office is likely to be better than that of a small one	7
1.84	Pos	7	A good working atmosphere is more likely to be found in a large office than a small one	1
2.30	Pos	8	A large office is definitely better to work in than a small one	3

Form of analysis of data

Three methods of analysis were applied to the data. The first was to test the homogeneity of the data, the second to rank the statements in the order of frequency with which they were chosen, and the third to derive scale values for the attitude of the respondents towards open planning.

The cross-tabulation and chi-squared analysis of data from the CIS questionnaires[23] had demonstrated the great degree of variability that may exist within such data. Age, sex, grade, and previous workplace were all shown to be determinants of the mode of response to a variety of environmental conditions. Previous workplace would, of course, no longer be relevant after two years in the new building and was therefore omitted from the present analysis. Also omitted was the respondent's grade as the sample was entirely composed of junior general clerical grades and excluded typists, machine operators, supervisors and managers. Because of the promotion system for junior grades, age and grade are virtually equivalent.

However, two additional variables were included for cross-tabulation. The first was the department in which the respondent worked. This was included in order to take account of any unsuspected physical influences, or those arising from differences in morale, supervision, or group composition. The second variable was the size of the area within which the respondent was located. This was included in order to allow for a comparison of results deriving from areas which were relatively open and those which were smaller and walled on three sides. Three such areas were located and, taken together, are subsequently referred to simply as the 'small areas'.

It had been intended to take the statement with which the respondent was most strongly in agreement (ie, the one double ticked) and weight its value in relation to the others. This proved to be impossible as, in a great number of cases, either more than one statement had been double ticked or it had not been done at all.

Results and discussion of results

(1) *Test of the homogeneity of the response pattern*

As with the first CIS questionnaire, the data was cross-tabulated and analysed by the chi-squared test for the independent samples.

Table 10

Analysis of response to statements by age group

Statement no	1	2	3	4	5	6	7	8	Total	χ^2	Number of respondents
Age group											
15 – 19	36	93	25	63	68	99	90	49	523	2.31	127
20 – 24	16	49	12	23	35	42	35	25	237	2.25	64
25 – 29	3	12	2	9	11	10	9	3	59	3.64	16
30 – 34	4	8	3	2	4	4	9	6	40	5.40	12
35 – 39	3	11	2	4	7	6	7	5	45	1.70	13
40 and over	20	37	13	30	20	29	30	24	203	7.27	63
	82	210	57	131	145	190	180	112	1107	22.57	295

Df=35, *NS*

Table 11

Analysis of response to statements by sex

Statement no	1	2	3	4	5	6	7	8	Total	χ^2	Number of respondents
Sex											
Male	27	72	20	41	43	51	60	42	356	3.51	100
Female	55	138	37	90	102	139	120	70	751	1.65	195
	82	210	57	131	145	190	180	112	1107	5.16	295

Df=7, *NS*

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[22] Additive quality of the scale is essential where it is intended to make comparisons between the strength of attitude held by different groups. It will usually hold only in cases where the psychological continuum is additive

[23] See chapter 10

Table 12
Analysis of response to statements by department in which employed

Statement no	1	2	3	4	5	6	7	8	Total	χ^2	Number of respondents
Department											
Department A	27	60	14	40	45	63	58	32	339	1.94	85
Department B	25	67	21	43	39	50	58	43	346	5.08	94
Department C	30	83	22	48	61	77	64	37	422	2.20	116
	82	210	57	131	145	190	180	112	1107	9.22	295
									$Df=14$, *NS*		

Table 13
Analysis of response to statements by comparison of large open areas and smaller semi-enclosed areas

Statement no	1	2	3	4	5	6	7	8	Total	χ^2	Number of respondents
Open areas	72	144	46	101	102	139	142	86	832	4.89	214
Small areas	10	66	11	30	43	51	38	26	275	12.65	81
	82	210	57	131	145	190	180	112	1107	17.54	295
									$Df=7, P<0.02$		

Of the four analyses performed, only in the one shown in table 13 was a significant result found. The three statements in which there was the greatest discrepancy between the observed and expected frequencies were those numbered 2, 1 and 5. To statement 2, it was the respondents in the small office areas who reported more frequently than the expected value derived from the table that the larger office makes one feel relatively unimportant. Similarly, in the case of statement 5, it was the respondents in the small areas who more often than the expected frequency reported that the large office creates less feeling of permanence and security than a small one. The distribution of replies to statement 1 was such that it was the people in the large areas who, more frequently than could be expected, supported the proposition that a good working atmosphere is more likely to be found in a large office than a small one. With only two rows in the table, the exact converse will also hold in each case, ie, a response of less than the expected value in one row will be mirrored by a frequency greater than the expected value for the other.

To summarize the results, the chi-squared analysis showed that the respondents were homogeneous in their responses to the attitude scale on the variables of age, sex and department, but significant differences were found to exist between the occupants of large and small areas. The difference was due to people in the large areas being better disposed towards open offices than the people working in the smaller ones.

Table 14
Final rank order of the statements forming the attitude scale

Rank order	Statement	Frequency chosen	Percentage of respondents
1	The larger offices make one feel relatively unimportant	210	71.2
2	There is an uncomfortable feeling of being watched all the time in a large office	190	64.4
3	The social life of a large office is likely to be better than that of a small one	180	61.0
4	The large office creates less feeling of permanence and security than a small one	145	49.2
5	The size of the office itself is not really important	131	44.4
6	Any disadvantages of the larger office are offset by greater advantages	112	38.0
7	A good working atmosphere is more likely to be found in a large office than a small one	82	27.8
8	A large office is definitely better to work in than a small one	57	19.3

(2) *Ranked distribution of scores*

A comparison of the rank order derived from the experimental data and the rankings made by the judges when the scale was established yields an interesting result.

The order of the statements listed above, when ranked by the judges, was 2, 1, 6, 3, 4, 5, 7, 8, where 1 is the statement least favourable towards the open plan office, and 8 the most favourable. A rank order correlation of these two rankings, using Kendall's coefficient τ,[24] yields a coefficient of 0.714. The critical value of τ at the 0.05 level of significance is 0.64. Thus significant correlation exists between the two rankings, implying a trend in the results such that the less favourable a statement is to the large office, the more frequently will it tend to be chosen.

(3) *Deriving the scale value*

In view of the fact that table 13 had revealed significant differences between the pattern of results obtained from people working in the large open areas and those working in the smaller ones, separate scale values were derived for each. An overall scale value was also derived by summing the scores from both types of area. The results were as follows:

Table 15
Mean values of individual median scores grouped by type of working area

Type of office space	Number of respondents	Sum of individual median scores	Mean values
Large area	214	207.39	0.969
Small areas	81	60.04	0.741
Large and small combined	295	267.43	0.907

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[24] $\tau = \frac{S}{\frac{1}{2}n(n-1)}$ where S is a score based on the comparison of each item with every other item

It has been shown[25] that the neutral point of this attitude scale, ie, the point at which neither a positive nor a negative feeling towards the open plan office is expressed, is 1.125. A score of less than 1.125 represents a negative attitude to the large office area, and a score above this represents a positive attitude.

Table 15 shows that the scale values derived for respondents working in both large and small areas are negative and so, of course, is the combined result. However, the more negative position on the scale is occupied by the respondents from the small areas. In other words, the people who work in small office areas are more opposed to large offices than those who actually work in them.

Item Three – Layout Preferences

Rationale and construction of the instrument

This item consisted of five photographs (which showed an office floor partitioned in various ways) which were to be ranked in order of preference from a paired comparison presentation.

The photographs were of a scale model which represented, in simplified form, the main elements of a CIS podium floor. Desks and chairs for two hundred workers were shown. In one picture the model was quite open and without partitioning, except for the central service area. The others showed it divided by panel partitions into two, four, six and eight smaller areas. Figure 93 shows a typical paired comparison.

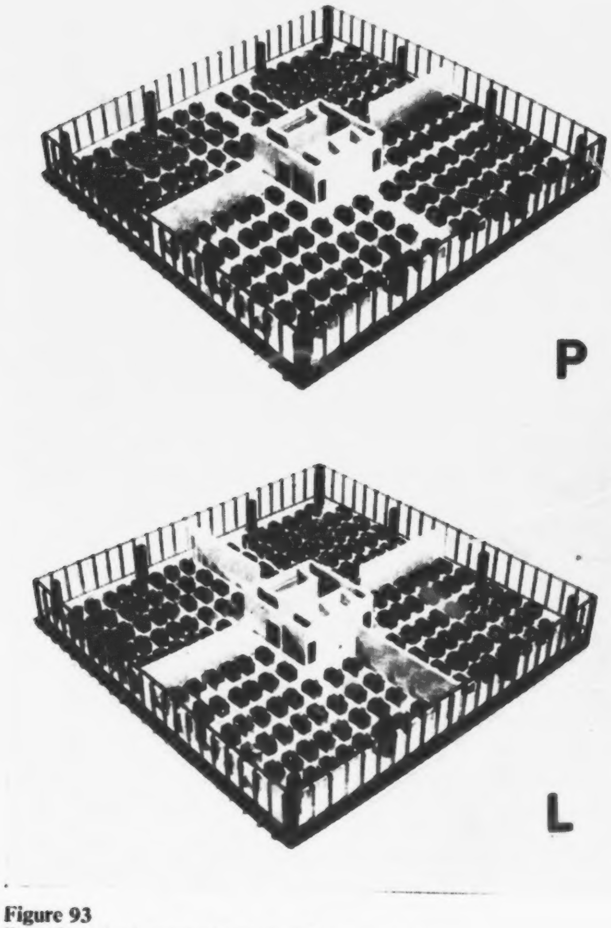

Figure 93
Sample paired comparison of office layouts.

The method of paired comparisons is usually employed where a relatively large number of objects has to be ranked, and where discrimination is anticipated as being difficult. In this instance, the number of objects to be ranked was not large, nor was it difficult to discriminate the magnitude of the difference between the alternatives. The method was used because it was hoped that it might reduce the chance of respondents adopting the single criterion of prefering the large or the small area (or vice versa), and thus not allowing the proper weight for any actually preferred intermediate alternative.

Ten paired comparisons were required in the present instance. Each picture was designated by one of the letters L M N O P. These were chosen in preference to A B C D E as being less likely to connote a progressive series. As an added precaution, the letters were randomized when they were assigned to a layout so as to prevent the respondent from forming a response set in terms of, say, the plan being progressively more open from L to P. The order in which the objects were paired (ie, above or below one another), and the order of presentation were also randomized.

An 'example slide' accompanied by another slide showing how the reply sheet was to be marked was shown to the respondents before the experimental slides proper. The technique requires that a judgement shall be recorded in every case, and this was asked for in the instructions.

Form of analysis of data

Paired comparison tables were constructed from the reply form in which, for any pair, the letter at the top represents the preference choice and the letter in the left hand row represents the non-preferred alternative in that particular comparison. It would perhaps have been desirable to calculate the coefficient of consistence for each judge at the time of grouping the results but this was not possible in the present case as, for values of n less than 6, significance cannot be proved.

Having prepared the paired comparisons table, the ranked order of preference is quite simply derived by summing the columns and attaching the highest rank to the highest score.

The homogeneity of the response pattern was tested by preparing separate tables for each of the variables of age, sex and department and then comparing them. Separate tables were also prepared for the respondents working in the large areas and those in the small ones, and these results compared.

Results and discussion of results

Comparison of results by age group

Table 16
15 to 19 years

	L	M	N	O	P	Totals
L		10	93	90	12	205
M	115		108	114	110	447
N	32	17		34	26	109
O	35	11	91		25	162
P	113	15	99	100		327
Totals	295	53	391	338	173	1250
Ranked order of preference	3	5	1	2	4	

n=125

Table 17
20 to 24 years

	L	M	N	O	P	Totals
L		12	44	43	12	111
M	52		49	53	52	206
N	20	15		24	16	75
O	21	11	40		17	89
P	52	12	48	47		159
Totals	145	50	181	167	97	640
Ranked order of preference	3	5	1	2	4	

n=64

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[25] **Wells, B. W. P:** op cit (18) (Statistical appendix 5)

Table 18
25 to 29 years

	L	M	N	O	P	Totals
L		1	11	9	3	24
M	14		13	15	15	57
N	4	2		1	1	8
O	6	0	14		3	23
P	12	0	14	12		38
Totals	36	3	52	37	22	150
Ranked order of preference	3	5	1	2	4	

n=15

Table 19
30 to 34 years

	L	M	N	O	P	Totals
L		2	9	10	2	23
M	10		9	11	11	41
N	3	3		5	1	12
O	2	1	7		0	10
P	10	1	11	12		34
Totals	15	7	36	38	14	120
Ranked order of preference	3	5	2	1	4	

n=12

Table 20
35 to 39 years

	L	M	N	O	P	Totals
L		1	8	10	2	21
M	12		10	12	11	45
N	5	3		4	2	14
O	3	1	9		4	17
P	11	2	11	9		33
Totals	31	7	38	35	19	130
Ranked order of preference	3	5	1	2	4	

n=13

Table 21
40 or more years

	L	M	N	O	P	Totals
L		16	43	42	15	116
M	46		49	52	49	196
N	19	13		27	16	75
O	20	10	35		19	84
P	47	13	46	43		149
Totals	132	52	173	164	99	620
Ranked order of preference	3	5	1	2	4	

n=62

Comparison of results by sex

Table 22
Male replies

	L	M	N	O	P	Totals
L		18	74	76	20	188
M	82		81	84	83	330
N	26	19		37	21	103
O	24	16	63		18	121
P	80	17	79	82		258
Totals	212	70	297	279	142	1000
Ranked order of preference	3	5	1	2	4	

n=100

Table 23
Female replies

	L	M	N	O	P	Totals
L		27	133	127	26	313
M	165		157	171	166	659
N	59	35		61	43	198
O	65	21	131		50	267
P	166	26	149	142		483
Totals	455	109	570	501	285	1920
Ranked order of preference	3	5	1	2	4	

n=192

Table 24
Male and female replies combined

	L	M	N	O	P	Totals
L		45	207	203	46	501
M	247		238	255	249	989
N	85	54		98	64	301
O	89	37	194		68	388
P	246	43	228	224		741
Totals	667	179	867	780	427	2920
Ranked order of preference	3	5	1	2	4	

n=292

Comparison of results by departments

Table 25
Department A

	L	M	N	O	P	Totals
L		9	63	64	8	144
M	76		71	77	76	300
N	22	14		30	16	82
O	21	8	55		14	98
P	77	9	69	71		226
Totals	196	40	258	242	114	850
Ranked order of preference	3	5	1	2	4	

n=85

Table 26
Department B

	L	M	N	O	P	Totals
L		16	64	60	20	160
M	77		76	79	72	304
N	29	17		29	24	99
O	33	14	64		29	140
P	73	21	69	64		227
Totals	212	68	273	232	145	930
Ranked order of preference	3	5	1	2	4	

n=93

Table 27
Department C

	L	M	N	O	P	Totals
L		20	80	79	18	197
M	94		91	99	101	385
N	34	23		39	24	120
O	35	15	75		25	150
P	96	13	90	89		288
Totals	259	71	336	306	168	1140
Ranked order of preference	3	5	1	2	4	

n=114

Comparison of results by size of working area

Table 28
Small areas

	L	M	N	O	P	Totals
L		11	56	60	11	138
M	69		66	70	65	270
N	24	14		17	16	71
O	20	10	63		15	108
P	69	15	64	65		213
Totals	182	50	249	212	107	800
Ranked order of preference	3	5	1	2	4	

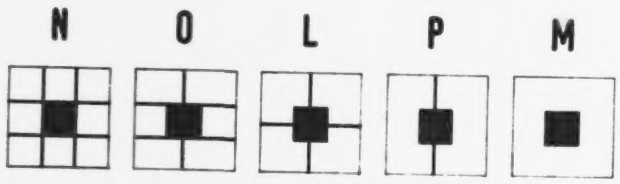
n=80

Table 29
Open areas

	L	M	N	O	P	Totals
L		34	151	143	35	363
M	178		172	185	184	719
N	61	40		81	48	230
O	69	27	131		53	280
P	177	28	164	159		528
Totals	485	129	618	568	320	2120
Ranked order of preference	3	5	1	2	4	

n=212

With only one exception, the rank order of preferences for the objects compared was exactly the same ie, N O L P M. This can be represented in the following way:



The exception was table 19 in which the first and second preferences were reversed by a very small margin. Apart from this, the rankings represent a consistent preference for smaller work areas. There was no difference between the pattern of replies for men and women, and no differences between different age groups, or different departments, or between those working in large open spaces and those in smaller areas.

Item Four – Social Considerations

Rationale and construction of the instrument

This item called for the respondents to make socio-preferential choices amongst their colleagues.

From the point of view of construction, devising a sociometric reply sheet is a perfectly common-sense procedure. Moreno,[26] who was principally responsible for the inception of the sociometric method, gives a general background to the preparation of such a document in his book 'Who shall survive?'. The most fundamental prerequisite in using such a technique is, of course, having the confidence of the respondents. In the present instance, the request for sociometric data came as the culmination of a two year research project within the company. The experimenter was therefore very well known to the respondents and on good personal terms with many of them, having spent a great deal of time working on the floor where this investigation was made and mixing socially in the coffee lounges and recreation room. It might also be expected that the study had derived a certain amount of acceptance from the fact that it was supported by the trade union, to which every employee belongs. At all stages in the project great care had been taken to secure the goodwill of the union so that it would be able to recommend the investigations to its members.

As Moreno, and many others since, have pointed out, it is essential to be specific about the conditions under which the preference choice is to be made ie, whether the choice is a work choice, a dining choice, a choice of sports companion, etc. The population from which the choices may be drawn must also be specified if the pattern of interactions is to be interpretable. In this case, the criterion of the socio-preferential choice was 'Which people would the respondent like to work beside?' The universe of choice was limited to other people working on the same floor.

The restriction of possible choices to a particular floor allowed for most of the possible face-to-face social interactions which might take place during working hours since most between-floor communication has to happen either by telephone or via the document conveyor. Between-floor preferences were allowed for under the heading of 'Additional information', in which each respondent was asked to give the number of his particularly good friends or acquaintances on other floors.

Selltiz and others[27] have drawn attention to the desirability of stating, where feasible, that the experimenter will arrange for the individual's preferences to be met if possible. This was not possible in the present case, and instead the experimenter took the alternative course recommended by Bjerstedt:[28] 'It may therefore often be advantageous to make the situation cognitively experimental, to stress that nothing will happen as a result of the findings. If there is no need for report-distortion the subject is likely to give a true answer; that is, after all, most natural and least laborious'.

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[26] **Moreno, J. L:** op cit (6)

[27] **Selltiz, C., Jahoda, M., Deutsch, M.** and **Cook, S. W:** Research methods in social relations. Methuen, 1959

As well as having the general goodwill and support of the subjects, it is also absolutely vital that they are assured of their anonymity and that their reply forms will be treated in an absolutely confidential manner. The written and spoken instructions made this abundantly clear, and also that the data was to be coded and transferred to punched cards and the questionnaires immediately destroyed. It is, though, the experimenter's belief that the greatest reassurance came not from promises made at the time, but from people's experience of the way in which other confidences, derived from two years of contact, had been maintained.

No limit was set to the number of choices that a respondent could make. Preferences were to be given in ranked order, and spaces were allowed for up to ten names on the reply form. As an additional motivator to the hesitant, the tape-recorded instruction 'Please try to list at least three people' was given half a minute after the first set of instructions. A total of two minutes was allowed to list the preferential choices, and one further minute to complete the additional information about friendships with people on other floors.

Form of analysis of data

The sociometric method is used principally as a tool for the examination of the social structure of groups of less than about forty people, and more usually still, for smaller ones. The techniques of analysis are therefore most developed for the small group. The original method described by Moreno[29] and still the most popular, entails drawing a diagram in which preferences or rejections are represented by lines between the individuals forming the group, after which the diagram is rearranged to make it perceptually more simple. It then remains to look for any trends, to establish who are the isolates in a group, and who are the 'stars'. The procedures involved are not systemmatic and the pattern tends to be exceedingly difficult to comprehend with large numbers.

To simplify the analysis, methods were developed in which the diagram was replaced by the matrix. Forsyth and Katz[30] developed a method in which the individuals of the group were listed in the same order down the rows and along the columns. The matrix was completed by entering the choices made by individuals in the row bearing his name and in the column of the person receiving that choice. This gave a picture almost as complicated as the diagram, but it could be simplified by rearranging the order of the columns and rows so that the entries in the matrix clustered as closely as possible about the main diagonal. The diagonal is, of course, composed of empty cells as it is formed by the point at which the individuals name appears in both the column and the row. The arrangement shows, in the clusters, those people who have chosen one another relatively frequently. The well separated entries represent the people who have not chosen one another.

However, the method of matrix analysis so far described is, as Festinger pointed out,[31] most useful for establishing changes within a group from one time to another and is of little value in demonstrating the existence of subgroups, or for comparing two groups. Festinger's own special contribution was to suggest a technique to allow for the determination of cliques within a group.

The above represent the three main types of analysis applied to sociometric data. There are almost innumerable variations of them, but none allow for a comparison of the social organisation of physically separated groups both of which form part of the same universe of choice. The usual situation involves taking two groups, each of which represents a separate universe, and comparing their internal sociometric structures. However, the present study is specifically concerned with the inter-group relationships and so it must be possible for the respondent to express his choices within his actual universe of choice, rather than an arbitrarily limited one. Therefore the results for the entire floor were treated together, with a corresponding gain in the validity of the data and a loss in the rigour of the analytic techniques available.

The main objectives of the analysis were threefold. Firstly to establish the number of choices directed outside of the section in which they were made. Secondly, to establish the number of reciprocated choices made within (i) the open areas and (ii) the partitioned areas X, Y and Z, and to compare them. Thirdly, to compare the numbers of isolates found in the open and the partitioned areas.[32]

Established techniques exist for calculating the number of isolates that might be expected to occur on a chance basis within a given group, and probability distributions have been derived.[33, 34, 35] However, these distributions depend upon the subjects making a known number of choices each, and the choices themselves being made within a single group. The method is not therefore applicable to the present case, where the problem is to compare two sub-groups of the same universe. This is not, however, to say that any special difficulty exists in determining the number of isolates in the subgroups, merely that it is not possible to determine the number that may be expected to occur in each of them on a chance basis.

Moreno[36] advocated the use of a specified number of choices, ie, 'Name three', 'Name five', etc, because of the advantages of being able to calculate the probable number of reciprocal choices and isolates to be found in a given group. He argued that allowing more choices would not alter the results; a higher choice rate would merely increase the frequency with which the more popular were chosen. This he termed the 'sociodynamic effect'. However, Bjerstedt[37] produced evidence to show that such an assumption is incorrect as stated. He demonstrated that the effect of allowing more choice is not the maintenance of the status quo, though most of the additional choices do indeed go to the more popular members of the group. The important difference is that small numbers also go to those people who would be described as 'isolates' under conditions of restricted choice. Restricted choice is therefore more useful for identifying the popular members of a group than for determining the number of true isolates: what is gained in analytical and computational advantages is lost in the consequent attenuation of the results. Thus, as one of the main hypotheses of the present study concerned the number of isolates in the sub-samples, the number of choices made was left unrestricted when analysing the data.

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[28] **Bjerstedt, A:** The methodology of preferential sociometry. Sociometry Monographs, no. 37, 1956

[29] **Moreno, J. L:** op cit (6)

[30] **Forsyth, E.** and **Katz, L:** A matrix approach to the analysis of sociometric data: preliminary report. Sociometry, 1946, 9 340-347

[31] **Festinger, L:** The analysis of sociograms using matrix algebra (In the Sociometry Reader, Ed: **Moreno, J. L.** Glencoe: Free Press, 1960)

[32] A reciprocated choice is one where two individuals mutually choose one another. An isolate is defined as a person unchosen, on the criterion of the test, by any of the other members of his group

[33] **Katz, L:** The distribution of isolates in a social group. (In the Sociometry Reader, Ed. **Moreno, J. L.** Glencoe: Free Press, 1960)

[34] **Moreno, J. L.** and **Jennings, H. H:** Statistics of social configurations. Sociometry, 1938, 1 342-374

[35] **Bronfenbrenner, U:** The measurement of sociometric status, structure and development. Sociometry, 1943, 6 363-397

[36] **Moreno, J. L:** Who shall survive? Foundations of sociometry, group psychotherapy and sociodrama. Beacon House, New York, 1953

[37] **Bjerstedt, A:** op cit (28)

Results and discussion of results

The analysis of results was undertaken in two stages: the first to determine the effect on socio-preferential choice of personal variables: the second to determine the effect of the spatial variables. A summary of much of the data for both is also given in the first stage.

Stage 1 (*The effect of personal variables*)

The first task in the analysis was the manual cross-tabulation of the total number of sociometric preferences made by each sex and age group.

Table 30 summarises the number and proportion of socio-preferential choices made and received by each age and sex group. The data serves to show the influence of age and sex as determinants of choice, and also the range of friendship choices to other parts of the building.[38] Choices to other parts of the building will be dealt with mainly in stage two, but the topic is also included at this stage as the data has been cross-tabulated with the age and sex of the people making them. It is therefore possible to consider the results of table 30 under three convenient headings:

(i) sex as a determinant of socio-preferential choice
(ii) age as a determinant of socio-preferential choice
(iii) friendship choices to other floors.

(i) Sex as a determinant of socio-preferential choice:

Column 3 shows that the average number of choices made by men and women is approximately the same; columns 4 and 5 show that men are more likely to refuse to record their preferences than are women.

It was found that the men, who represent 31 percent of the sample, in fact received 36 percent of all the stated preferences; whereas the women, who represent 69 percent of the sample received 64 percent of the total of choices made. However, as columns 6 and 7 show, the great majority of choices made by a given sex were directed towards members of the same sex. This held for the entire range of age groups, and it therefore appears that sex is an important determinant of choice pattern. This is not, of course, a novel or unexpected finding; indeed, any other result would have been surprising. The value of the findings are not therefore intrinsic but they establish the relative weight to be given to sex when the influence of other determinants is considered.

(ii) Age as a determinant of socio-preferential choice:

The youngest age group, ie, the 15 to 19 year olds, composed the numerically largest group and made the greatest absolute number of choices. In all, they made 48 percent of the total preference choices recorded, but received only 35 percent of the choices themselves. Conversely, with the exception of the over 40 age group, all other groups received more choices than they made. It appears therefore that older working companions are generally more acceptable than younger ones.

It is interesting to note from columns 6 and 7 that there is a tendency for the proportion of men being chosen by women to rise with age group. On the other hand, the proportion of women chosen by men declines with the older age groups. The reasons for this are not apparent from the results and so one must postulate some other factor: differences, for example, in the relative attractiveness of the two sexes for one another at different ages.

Inspection of the cells in the centre of the table where the figures are in bold type shows that each age group tends to choose predominantly from the members of its own age group. This is most marked for the numerically larger age groups: members of the smaller ones, presumably, are more cut-off from members of their own age group. With the single exception of the 30 to 34 year age group it is members of the next younger or older age group who are next most frequently chosen, ie, the age groups to the immediate left or right of the groups in the bold type diagonal. In fact, the proportion of choices made to members of the same age group and those immediately adjacent are:

15 to 19	85 percent
20 to 24	80 percent
25 to 29	65 percent
30 to 34	79 percent
35 to 39	85 percent
40 or more	71 percent

As with the case of sex, it is clear that age group also is a very potent factor in determining the preference choices. Again, the finding is neither novel nor unexpected, but a necessary step in evaluating the factors responsible for socio-preferential choice.

(iii) Friendship choices to other floors:

Column 14 shows that, as might be expected, the number of friendship choices to other floors is greater with the older than with the younger groups. This is presumably because they will have had more opportunities to make contacts over the years and will, perhaps, have worked in more departments.

The 'average' row of column 14 also shows that it is the men who make the greatest number of choices to other parts of the building. With junior grades there is no reason to suppose that the men have any greater opportunity to interact with members of other floors than have the women. This is perhaps due to the existence of such secondary social networks as the sports club and the union, both of which are almost entirely in the hands of men. The informal social networks of the women, by contrast, tend to depend to a greater extent on meetings during working hours. The largest such network derives from the lunchtime dances in the recreation hall, where girls who work and eat together also dance together. Lunchtime dancing is now, by custom, an entirely female affair.

It might be expected that, in cases where the work requires co-operation, the resulting inter-personal contact would be most important in determining socio-preferential choice. However, there is comparatively little co-operative work on the floor where the study was made: with only few exceptions, clerks working on this floor have fairly discrete tasks. Some clerks transfer data from letters to proposal or application forms, from documents to cards, or from cards to documents. And in this respect there are no differences between sections occupying separate, semi-enclosed areas and those in the open ones. Being a member of one work section rather than another amounts, therefore, to a mainly administrative allegiance coupled, perhaps, with a special concern for a given business area. Thus, as the frequency of working interactions was fairly low, and was comparable for the two types of area studied, it has not been given any special place in this discussion.

Stage 2 (*The effect of spatial variables*)

The effect of distance as a variable affecting the formation of friendships may be regarded as operating on two levels. The first level is concerned with gross distances of the sort existing between different parts of a building. The second is concerned with very much smaller distances separating individuals in the same part of a building. Both will depend to a large extent upon functional relationships.

Columns 14 to 18 of table 30 summarize the number of friendship relationships claimed by workers on the floor surveyed to exist between themselves and workers on other floors. They show that it is the higher podium floors which attract most choices; the higher floors in the tower next; the lower podium floors third. The lower tower floors attract fewest choices and the explanation for this is probably that these floors have no functional relationships with the sub-departments on the floor surveyed whereas the other groups of floors do. It might

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[38] A substantial number of the respondents completing the rest of the questionnaire left this particular item blank and they were therefore not included in the analysis, though their number is shown in column 4 of table 30. Their names were also excluded from the preferences made by other people and so they effectively ceased to exist as members of the population studied

Table 30

Summary table of sociometric preferences cross-tabulated by age group and sex

Age groups and sex	(1) Number of respondents completing form	(2) Number of named preferences given	(3) Average number of named preferences given	(4) Number of respondents not replying	(5) Percentage of respondents not replying (column 4 as percentage of column 1)	(6) Choices to males		(7) Choices to females		(8) Choices to 15 to 19 year group		(9) Choices to 20 to 24 year group		(10) Choices to 25 to 29 year group		(11) Choices to 30 to 34 year group		(12) Choices to 35 to 39 year group		(13) Choices to 40 + age group		(14) Friendship choices to other floors		(15) Choices to lower floors of podium		(16) Choices to other floors in podium		(17) Choices to nearest six floors in tower		(18) Choices to remaining floors in tower	
						Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Per cent (of col 2)	Number	Average (of col 1)	Number	Per cent (of col 14)	Number	Per cent (of col 14)	Number	Per cent (of col 14)	Number	Per cent (of col 14)
15 to 19 years:																															
Male	21	91	4.3	2	8.7	64	70.3	27	29.7	**48**	**52.7**	19	20.9	14	15.4	2	2.2	5	5.5	3	3.3	84	4.0	18	21.4	35	41.7	11	13.1	20	23.8
Female	95	378	4.0	9	8.7	53	14.0	325	86.0	**227**	**60.1**	103	27.2	9	2.4	8	2.1	10	2.6	21	5.6	209	2.2	31	14.8	105	50.2	34	16.3	39	18.7
Totals	116	469	4.0	11	8.7	117	24.9	352	75.1	**275**	**58.6**	122	26.0	23	4.9	10	2.1	15	3.2	24	5.1	293	2.5	49	16.7	140	47.8	45	15.4	59	20.1
20 to 24 years:																															
Male	21	103	4.9	1	4.5	76	73.8	27	26.2	23	22.3	**50**	**48.5**	17	16.5	4	3.9	5	4.9	4	3.9	80	3.8	14	17.5	16	20.0	20	25.0	30	37.5
Female	36	158	4.4	6	14.3	22	13.9	136	86.1	52	32.9	**74**	**46.8**	5	3.2	9	5.7	7	4.4	11	7.0	64	1.8	6	9.4	34	53.1	6	9.4	18	28.1
Totals	57	261	4.6	7	10.9	98	37.5	163	62.5	75	28.7	**124**	**47.5**	22	8.4	13	5.0	12	4.6	15	5.7	144	2.5	20	13.9	50	34.7	26	18.1	48	33.3
25 to 29 years:																															
Male	3	18	6.0	1	25.0	14	77.8	4	22.2	2	11.1	3	16.7	**5**	**27.8**	6	33.3	0	0	2	11.1	18	6.0	2	11.1	4	22.2	1	5.6	11	61.1
Female	9	45	5.0	3	25.0	11	24.4	34	75.6	5	11.1	9	20.0	**9**	**20.0**	9	20.0	6	13.3	7	15.6	32	3.6	9	28.1	10	31.3	1	3.1	12	37.5
Totals	12	63	5.3	4	25.0	25	39.7	38	60.3	7	11.1	12	19.0	**14**	**22.2**	15	23.8	6	9.5	9	14.3	50	4.2	11	22.0	14	28.0	2	4.0	23	46.0
30 to 34 years:																															
Male	6	27	4.5	2	25.0	23	85.2	4	14.8	0	.0	1	3.7	6	22.2	**15**	**55.5**	1	3.7	4	14.8	17	2.8	3	17.6	8	47.1	2	11.8	4	23.5
Female	3	21	7.0	1	25.0	6	28.6	15	71.4	0	.0	1	4.8	5	23.8	**9**	**42.9**	2	9.5	4	19.0	15	5.0	5	33.3	10	66.7	0	0.0	0	0
Totals	9	48	5.4	3	25.0	29	60.4	19	39.6	0	.0	2	4.2	11	22.9	**24**	**50.0**	3	6.2	8	16.7	32	3.6	8	25.0	18	56.3	2	6.2	4	12.5
35 to 39 years:																															
Male	5	21	4.2	3	37.5	17	81.0	4	19.0	0	.0	2	9.5	1	4.8	6	28.6	**6**	**28.6**	6	28.6	30	6.0	7	23.4	7	23.3	4	13.3	12	40.0
Female	4	13	3.3	1	20.0	0	0	13	100.0	1	7.7	1	7.7	0	0	3	23.1	**2**	**15.4**	6	46.2	10	2.5	3	30.0	1	10.0	0	0	6	60.0
Totals	9	34	3.8	4	30.8	17	50.0	17	50.0	1	2.9	3	8.8	1	2.9	9	26.5	**8**	**23.5**	12	35.3	40	4.4	10	25.0	8	20.0	4	10.0	18	45.0
40 or over:																															
Male	19	69	3.6	12	38.7	58	84.1	11	15.9	2	2.9	6	8.7	1	1.4	8	11.6	21	30.4	**31**	**44.9**	76	4.0	11	14.5	30	39.4	11	14.5	24	31.6
Female	19	76	4.0	13	40.6	27	35.5	49	64.5	1	1.3	7	9.2	3	3.9	14	18.4	14	18.4	**37**	**48.7**	72	3.8	24	33.3	17	23.6	9	12.5	22	30.6
Totals	38	145	3.8	25	39.7	85	58.6	60	41.4	3	2.1	13	9.0	4	2.8	22	15.2	35	24.1	**68**	**46.9**	148	3.9	35	23.6	47	31.8	20	13.5	46	31.1
All age groups combined:																															
Male	**75**	**329**	**4.4**	**21**	**21.9**	**252**	**76.6**	**77**	**23.4**	**75**	**22.8**	**81**	**24.6**	**44**	**13.4**	**41**	**12.5**	**38**	**11.6**	**50**	**15.2**	**305**	**4.1**	**55**	**18.0**	**100**	**32.8**	**49**	**16.1**	**101**	**33.1**
Female	**166**	**691**	**4.2**	**33**	**16.6**	**119**	**17.2**	**572**	**82.8**	**286**	**41.4**	**195**	**28.2**	**31**	**4.5**	**52**	**7.5**	**41**	**5.9**	**86**	**12.5**	**402**	**2.4**	**78**	**19.4**	**177**	**44.0**	**50**	**12.4**	**97**	**24.1**
Grand totals	**241**	**1020**	**4.2**	**54**	**18.3**	**371**	**36.4**	**649**	**63.6**	**361**	**35.4**	**276**	**27.0**	**75**	**7.4**	**93**	**9.2**	**79**	**7.7**	**136**	**13.3**	**707**	**2.9**	**133**	**18.8**	**277**	**39.2**	**99**	**14.0**	**198**	**28.0**

be expected that, other things being equal, the higher tower floors would attract more choices than the lower floors because they contain many more workers (ie, 736 compared with 441). Thus there exists the possibility of greater numbers of random contacts between individuals entering or leaving the building, or in the canteens, smoke or recreation rooms.

The possibility that between-floor friendships would be most numerous where floors shared the same shift was investigated and found untenable: not because of any contrary evidence, but because of the form in which the results were collected. Floors were grouped together in an arbitrary way on the reply form, whereas the shifts themselves are evenly distributed throughout the building. Therefore some departments in each of the groupings given on the reply form share the same shift as the experimental floor. But if any relationship between inter-floor friendships and shift did exist, the effect would be diluted: the shifts are staggered by only five minute intervals and so there is a great deal of overlap anyway.

Undoubtedly though, the most interesting findings arising from the data on between-floor friendship links is their very great number. An average of 2.9 friendship links with people on other floors of the building conveys the impression of an organization in which there is a great deal more interaction between individual members of the company than might be supposed from the way in which work is organized. For, not only are interpersonal contacts between floors minimised by the mechanical document conveyor but there is also an active management policy of stopping any between-floor traffic.

The explanation no doubt owes much to the social provisions within the building though, for the reasons discussed above, no causal link can be demonstrated.

The social consequences of spatial relationships within a restricted part of a building is, however, a matter more closely concerned with the hypotheses being tested. The data necessary to test the hypotheses is contained in tables 31, 32 and 33.

Tables 31 and 32 are concerned with the sheer effect of physical distance on the different age and sex groups. They were prepared by measuring, on a scale floor plan, the distance between the person making the preference choice and the person receiving it. The name of every individual participating had previously been written against their desk position on the plan in order to facilitate such cross-referencing.

The totals row of table 31 shows a very clear pattern: the number of socio-preferential choices decreases steadily with distance. The only exception to the trend is the case of distances of more than 36 ft, where the number is slightly above that for the 25 to 36 ft group, and is presumably the result of grouping together several possible distance categories.

One interesting effect apparent from the results in column 2 is that the younger age groups choose the highest proportion of people from those within one desk distance, and the general trend is for this proportion to fall with age. Conversely, inspection of column 6 shows that there is a general trend for older groups to select a higher proportion of their workmate choices from the over 36 ft distance. This is an effect that might be expected from the tendency, already demonstrated, for choices to be made from members of the same age group. As the older age groups are in a minority, the individuals composing them must be relatively more isolated from one another, and the number of choices to greater distances relatively higher.

Table 32 compares the distances involved in the socio-preferential choices made by men and women. The frequency distribution of choices at various distances is broadly the same, but there is a slight tendency for men to draw a higher proportion of their choices from further away. As with the older age groups men, being a minority, are relatively more isolated from one another. Having been shown to be an important determinant of socio-preferential choice, sex would therefore be expected to result in choices being made over somewhat greater distances.

Socio-preferential choice seems, therefore, to be a result

Table 31
Distance of respondents from sociometric choice cross-tabulated with age group

Age group	(1) Number of choices made by group	Distance of respondent from choice									
		(2) 12ft or less		(3) 13 to 18ft		(4) 19 to 24ft		(5) 25 to 36ft		(6) More than 36ft	
		Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)
15 – 19	469	187	39.9	129	27.5	64	13.6	41	8.7	48	10.2
20 – 24	261	111	42.5	78	29.9	34	13.0	22	8.4	16	6.1
25 – 29	63	20	31.8	12	19.0	12	19.0	11	17.5	8	12.7
30 – 34	48	18	37.5	10	20.8	12	25.0	4	8.3	4	8.3
35 – 39	34	12	35.3	6	17.6	7	20.6	4	11.8	5	14.7
40 or more	145	46	31.8	28	19.1	19	13.1	19	13.1	33	22.8
Totals	1020	394	38.6	263	25.8	148	14.5	101	9.9	114	11.2

Table 32
Distance of respondents from sociometric choice cross tabulated with sex

Sex	(1) Number of choices made by group	Distance of respondent from choice									
		(2) 12ft or less		(3) 13 to 18ft		(4) 19 to 24ft		(5) 25 to 36ft		(6) More than 36ft	
		Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)	Number	Percentage (of col 1)
Male	329	114	34.7	75	22.8	63	19.1	40	12.2	37	11.2
Female	691	280	40.5	188	27.2	85	12.3	61	8.8	77	11.1
Totals	1020	394	38.6	263	25.8	148	14.5	101	9.9	114	11.2

Table 33
Summary table of sociometric choices made and reciprocated within sections and departments, including the number of isolates in each

Type of office space	(1) Number of respondents completing form	(2) Number of named preferences given	(3) Average number of preferences given	(4) Number of respondents not replying	(5) Percentage of respondents not replying (Column 4 as percentage of cols 1 plus 4)	(6) Choices to members of respondents own section		(7) Choices to members of respondents own department		(8) Reciprocated choices within single section		(9) Reciprocated choices within single department		(10) Unchosen individuals (isolates)	
						Number	Per cent of col 2	Number	Per cent of col 2	Number	Per cent of col 2*	Number	Per cent of col 2*	Number	Per cent of col 1
Open areas	174	779	4.5	40	18.7	498	63.9	710	91.1	147	37.7	207	53.1	8	4.6
Small areas	67	241	3.6	14	17.3	195	80.9	229	95.0	80	66.4	84	69.7	6	9.0
Totals	241	1020	4.2	54	18.3	693	67.9	939	92.1	227	44.5	291	57.1	14	5.8

* The percentage is calculated from twice the actual number of reciprocated choices. This was done because each reciprocal choice involves two choices taken from the total in column 2

of the simultaneously acting vectors [39] deriving from age, sex and inter-personal distance.

Table 33 summarizes the sociometric choices made and reciprocated within sections and departments, and the number of isolates found in each. The data from the small areas is compared with that from the remainder of the floor. Column 1 shows the number completing and column 4 the number refusing the sociometric question. Column 5 shows that the percentage of workers in the large and small areas who did not state their preferences was almost identical. [40]

Column 3 shows that there exists a very substantial difference between the average number of choices made by workers in the open areas and those in the small. People working in the larger office spaces produced the greater outgoing choice volume: in sociometric terms they exhibited a higher level of 'expansivity' than workers in the small areas.

Columns 6 and 7 show that the socio-preferential choices of workers in the small areas were very much more frequently made from among members of their own section, and somewhat more frequently from members of their own department, than were those of the open area personnel. Columns 8 and 9 show that this greater proportion of choices made within a single section or department was also paralleled by a much greater proportion of choices reciprocated within them. The fact that the proportion of intra-departmental reciprocated choices was much higher for members of the small areas than members of the large is, though, a consequence of the great number of intra-section reciprocated choices. In fact, the number of reciprocated choices with members of the same department, other than members of the same section, is very much lower.

The results therefore show that there exists a much greater degree of internal cohesion [41] amongst the members of sections working within the smaller areas than amongst those working in the open ones. However, the number of isolates is greater. Column 10 shows that, though their numbers are small, there are proportionally almost twice as many in the small areas. If spatial relationships are important factors in determining the socio-preferential choice, then one might anticipate such a result as a higher proportion of workers in a small area must perforce be relatively physically isolated by working in a corner or beside a wall.

To summarize the results, it was found that both age and sex were important determinants of socio-preferential choice but, allowing for this, they tend to operate within the framework of spatial relationships. As the sections working in both the open and the small areas were essentially similar in both the nature of the work and composition of the sub-samples, differences in sociometric pattern must be attributable to differences in the size of area in which they worked.

It was found that the social organization of the sections working in small areas was internally more cohesive, though the proportion of isolates was higher, and the number of wider links with other members of the same department much smaller.

The higher average number of socio-preferential choices made by members of the open areas, coupled with the lower proportion of reciprocations, shows that the socio-occupational network existing in the two types of area are fundamentally different. In the small areas there exists a fairly tight social group, whereas the social links connecting people in the open areas are much less tightly knit.

Item Five – Choice of Working Position

Rationale and construction of the instrument

This item represents a direct and empirical approach to the question of preferred office size.

The stimulus was a projected photograph of the model used for the earlier paired-comparison items. The photograph had been taken square-on, and from a higher angle, to present what amounted to a three-dimensional floor plan, though it differed from a floor plan in that it was more representational and less schematic.

Four working areas of different sizes were partitioned-off from each other. The smallest area contained only ten desks, the next largest contained thirty, the next sixty, and the largest one hundred. Except for the smallest area, divisions of approximately the same size as each of the others in the model are to be found on the floor of the CIS which was chosen for the experiment and are therefore familiar to the respondents. The smallest area represents perhaps the idealisation of the small working area but there is only one example of it in the whole of the building, a wages section on the seventeenth floor.

In response to the projected picture the respondent was required to mark on a half-tone reproduction in the reply form, the desk at which he would choose to work. The slide had a brilliance and tonal range much greater than the print and thus appeared very much more detailed and realistic.

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[39] Vector: 'A directed magnitude in the life space; a force causing psychological locomotion'. (**English, H. B. and English, A. C**: A comprehensive dictionary of psychological and psychoanalytical terms. London, Longmans, Green. New York, David McKay Company Inc. 1958)

[40] Many of the refusals were of the form 'no particular preference', or 'I get along quite well with most people'. They are not, therefore, necessarily a refusal to co-operate but may reflect a genuine lack of strongly held preferences

[41] Cohesion: 'The total field of forces inside and outside the group, which tend to keep it intact'. (**English, H. B. and English, A. C**: op cit (39)

Photographs of real offices would have been preferred for both this item and the paired comparisons one, but attaining the uniformity of conditions, equipment, design and occupation was out of the question. Even if this had proved possible, it would not have been possible to get views uncomplicated by extraneous considerations such as the view from the windows, or distorted proportions due to the photographic perspective. It was decided that photographs of real buildings would introduce too many uncontrolled variables, and that a model would be more likely to produce a choice due solely to the respondent's preferred size of office.

A completely open question was included as to the basis for the respondent's choice, and a one minute pause allowed in the programme for a reply.

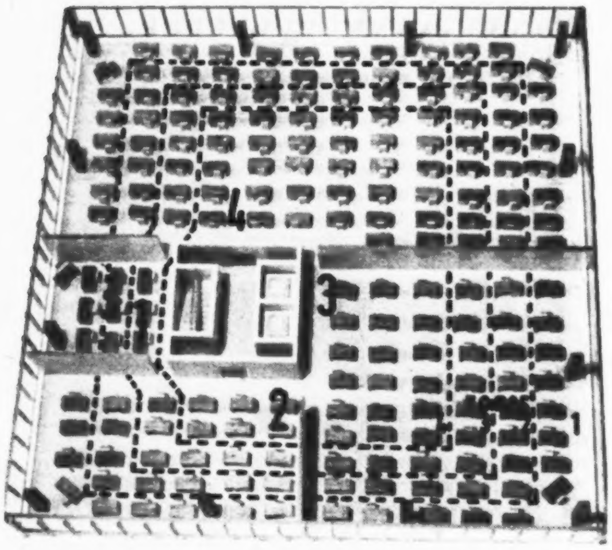

Figure 94
The photograph of the model with the areas and zones superimposed.

Form of analysis of data

The total floor area from which the respondent could make his choice was divided into four smaller areas and numbered from 1 to 4, as in figure 94. The areas themselves were then divided into zones and numbered from 1 to 4. Zones 1 to 3 each represent the row number of the desk from the window. Zone 4 contains the remaining desks in the centre of the floor. Area 1 has only 3 zones as it is composed of only 3 rows of desks.

The frequency with which each area and zone was chosen was then cross-tabulated with the age and sex of the respondent, and also the type of office space in which he or she was working, ie, in one of the small areas or in the remaining open areas (tables 34, 35 and 36).

Results and discussion of results

The totals columns of tables 34 to 36 show the very great

Table 34
Choice of working position: summary of results cross-tabulated with age group

Age group	Area 1			Area 2				Area 3				Area 4				Totals
	Zone			Zone				Zone				Zone				
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4	
15 to 19	34	2	2	35	5	4	1	18	6	3	1	12	2	1	0	126
20 to 24	24	1	0	17	2	0	1	9	1	2	1	5	0	1	0	64
25 to 29	5	0	0	4	1	0	0	3	1	1	0	0	0	0	0	15
30 to 34	1	1	1	3	0	0	0	2	0	0	0	2	1	1	0	12
35 to 39	4	0	0	3	2	0	1	1	0	1	0	0	1	0	0	13
40 +	24	2	2	19	0	1	0	8	1	1	0	2	1	0	1	62
Totals	92	6	5	81	10	5	3	41	9	8	2	21	5	3	1	292

Table 35
Choice of working position: summary of results cross-tabulated with sex

Sex	Area 1			Area 2				Area 3				Area 4				Totals
	Zone			Zone				Zone				Zone				
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4	
Male	34	1	3	25	6	1	2	12	3	2	1	7	2	1	0	100
Female	58	5	2	56	4	4	1	29	6	6	1	14	3	2	1	192
Totals	92	6	5	81	10	5	3	41	9	8	2	21	5	3	1	292

Table 36
Choice of working position: summary of results cross-tabulated with type of office space occupied by respondent

Type of office space	Area 1			Area 2				Area 3				Area 4				Totals
	Zone			Zone				Zone				Zone				
	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4	
Open areas	55	5	4	66	6	3	2	31	6	7	2	18	4	2	1	212
Small areas	37	1	1	15	4	2	1	10	3	1	0	3	1	1	0	80
Totals	92	6	5	81	10	5	3	41	9	8	2	21	5	3	1	292

frequency with which a desk immediately adjoining a window was chosen. In all, 81 percent of choices were within Zone 1, with the remaining frequencies dropping steadily from Zones 2 to 3 to 4, ie, 10, 7 and 2 percent respectively.

Tables 37, 38 and 39 were prepared by grouping the zones together and summarising the results by choice of area only. This was done in order to allow for a chi-squared test of the homogeneity of the sub-samples, and would have been impossible with the large number of empty or low value cells in tables 33 to 36. The method of k independent samples was employed.[42]

The chi-squared tests showed that the pattern of results was not significantly different between the age groups or the sexes, though the type of office in which the respondent was working did result in a significant difference. The main source of this difference was due to respondents in the open areas choosing Area 2 beyond the frequency expected from the total table, whereas respondents in the small areas chose Area 1 beyond the expected frequency.

The final order in which the four areas may be ranked on the basis of frequency of choice is 1,2,3,4, with very little difference in the frequencies with which areas 1 and 2 were chosen. Both areas may be regarded as falling within the definition of a small office; the results therefore show a clear preference for the smaller working area.

Table 37
Choice of working position: frequency with which each area was chosen, cross-tabulated with age group

Age group	Area 1	Area 2	Area 3	Area 4	Totals	χ^2
15 to 19	38	45	28	15	126	1.56
20 to 24	25	20	13	6	64	0.39
25 to 29	5	5	5	0	15	0.70
30 to 34	3	3	2	4	12	
35 to 39	4	6	2	1	13	
40 +	28	20	10	4	62	3.22
Totals	103	99	60	30	292	5.87

Df=9, *NS*

Table 38
Choice of working position: frequency with which each area was chosen, cross-tabulated with sex

Sex	Area 1	Area 2	Area 3	Area 4	Totals	χ^2
Male	38	34	18	10	100	0.53
Female	65	65	42	20	192	0.27
Totals	103	99	60	30	292	0.80

Df=9, *NS*

Table 39
Choice of working position: frequency with which each area was chosen, cross-tabulated with type of office space occupied by respondent

Type of office space	Area 1	Area 2	Area 3	Area 4	Totals	χ^2
Open areas	64	77	46	25	212	2.54
Small areas	39	22	14	5	80	6.73
Totals	103	99	60	30	292	9.27

Df=3, $P < 0.05$

Table 40
Summary of reasons given for choices* of working position

Category	Reason	Frequency		
		Number	Percent of respondents	
1	Natural daylight	94	32.2	nearness to windows
2	Near window (not further specified)	76	26.0	
3	More or brighter light	44	15.1	
4	View from window	12	4.1	
5	Not too near windows	7	2.4	
6	Preference for office size (either large, medium or small)	73	25.0	inter-personal considerations
7	Privacy (usually back or side of room)	20	6.8	
8	To be surrounded by people	14	4.8	
9	Near airconditioning outlet (perimeter of floor)	12	4.1	
10	Miscellaneous unspecified **	10	3.4	
11	No reason given	9	3.1	
	Total number of reasons given	371		*n*=292

* Some respondents gave more than one reason
** Idiosyncratic reasons and those which were given less than 3 times (ie, by less than one percent of people) were not assigned a separate category

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[42] As in the analysis of the first CIS questionnaire. See: Wells, B. W. P: op cit (18)

Table 40 summarizes the reasons given by respondents for making their choice as they did. It had been supposed that the replies would hinge mainly on preferred *size* of office as the mental set [43] for thinking about office size should already have been created and, except in respect of size, the areas from which the choice could be made were essentially similar. However, the reasons given for making the choice were more frequently in terms of a positive desire to work beside a window. (Combining categories 1 to 4 reveals that 77 percent of respondents offered this reason). Reasons involving office size or other inter-personal considerations cover only 37 percent of respondents (combining categories 6 to 8). It would, though, be misleading to suppose that office size was not a major determinant of the way in which the choice was made. The distribution of choices to different areas and the way in which these have been shown to be influenced by the respondents' own working experience make it clear that it is. The results serve to show that such demonstrably important psychological determinants of preference behaviour are not always apparent from a verbal report.

PART TWO : SECTION CLERKS

Hypothesis to be tested

Many free-ranging conversations with section clerks (ie, supervisors) had conveyed to the experimenter the impression that they were the group most firmly opposed to the open plan offices. The comments recorded in chapter 10, derived from the formal group interviews held shortly after the move to the new building, typified their views. Greater familiarity with the open plan resulted in no better an opinion of it; supervisors still felt that they and their sections would be happier and more effective in small office units. Accordingly, the following hypothesis may be formally stated:

Hypothesis: Supervisory staffs will choose to have their own groups separated off from those of other supervisors.

Apart from testing this formal hypothesis, the study also serves to establish what the floor supervisor feels to be the relative advantages and disadvantages of the open plan office.

Population and samples used

The sample used in the study was every section clerk working on the experimental floor. A total of 20 individuals were involved, all male.

Method of investigation

A questionnaire (Supplement 4), was addressed personally to each section clerk and prefaced by a letter from the experimenter (Supplement 3). Both questionnaire and letter were themselves sent out under another covering letter from the General Manager, which requested the recipient to co-operate fully in completing the questionnaire and to attend a group session which had been arranged. The questionnaire was circulated on Tuesday, 19th May, with the instructions that it was to be completed by the afternoon of Tuesday 26th May, and brought along to a group session in the recreation room where the final item could be completed.

The recreation room session was held at 3.0 p.m. The managers who were involved in the study (whose results are presented separately in Part Three) also attended. The first item on the agenda was to project the paired comparison slides, which comprised the last item on the questionnaire. Following this the experimenter gave a short talk on his research interests and, after tea, led a discussion on the psychological implications of aspects of office design, with particular reference to office size.

Construction of the questionnaire

The instructions given on the questionnaire requested the respondent to reply to the questions strictly in terms of supervisory considerations, to ignore any others – such as the general level of office noise, ventilation and heating – that they might feel to be involved, and to avoid discussing the content of the document until after it had been returned.

Question 1 summarised the six principal ways of physically separating clerical working units, and asked for reactions to them on a five point scale ranging from very favourable to very unfavourable. Direct rankings were not asked for as it was not known whether the alternatives could be ranked on a unidimensional scale, ie, x or y could both be 'very acceptable'. Indeed, any number of categories could be equally acceptable, or equally unacceptable, for a variety of different reasons. Five point scales were also used for questions 2 to 6 for responses to a number of questions about the personal and supervisory consequences of different office sizes. The investigation, being exploratory rather than theory-orientated, posed questions connected with a range of topics from the way in which clerks are treated in large offices, to the ease with which supervisory duties may be carried on in large and small office areas. Such items are empirical and thus have face and not scale validity. On the other hand, question 7, which is the attitude scale described and used in Part One, does have scale validity. The penultimate item in the questionnaire was a completely open question asking for either an elaboration of the replies given to specific questions in the questionnaire, or comments on any other matter concerning supervision which was not touched on in direct questioning.

The final item of the questionnaire was the paired comparisons of alternative office floor layout, the construction and presentation of which has been described fully in Part One.

Results

The section clerks ratings of the alternative methods of de-limiting an office area are given in table 41.

In view of the fact that no one registered a reply in the 'Indifferent' column, the data may be given simple

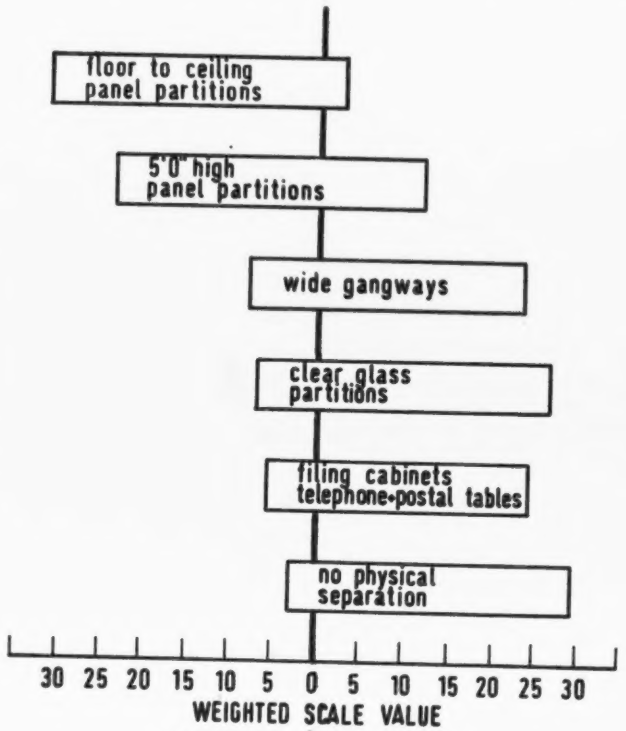

Figure 95
Ranked order and degree of favourableness—unfavourableness to the alternative methods of dividing office space.

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[43] Mental set: 'a preparatory adjustment or readiness for a particular kind of action or experience'. (English, H. B. and English, A. C: op cit (39)

Table 41
Section clerks' ratings of alternative methods of dividing a single office space for 4 to 6 sections, comprising 100 to 150 people.

Type of space division	Very favourable	Moderately favourable	Indifferent	Moderately unfavourable	Very unfavourable	Totals
(i) Sections not physically separated from one another	1	2	0	5	12	20
(ii) Five foot high panel partitioning between sections	11	2	0	3	4	20
(iii) The use of filing cabinets, telephone and postal tables, etc as boundaries between sections	0	6	0	5	9	20
(iv) Floor to ceiling panel partitioning between sections	15	2	0	1	2	20
(v) Wide gangways separating sections	2	4	0	4	10	20
(vi) Clear glass partitioning between sections	1	5	0	3	11	20

$n=20$

graphic expression on a bi-polar frequency histogram (figure 95). In drawing this, the 'Very favourable' and 'Very unfavourable' replies have been given an arbitrary χ^2 weighting, and the 'Moderately' held replies given no added weight. Each alternative has been ranked in the histogram downwards from the most favourable alternative to the least favourable. Even if no differential weighting was given to the 'Very favourable' replies, the ranked order would not change, except that alternatives (v), (vi) and (iii) would occupy a tied rank rather than being separated by marginal differences as they are in the histogram.

The table of results and histogram together show a very strong preference for panel (ie, opaque) partitioning, and for partitions extending from floor to ceiling in preference to partitioning only 5 ft high. Wide gangways, clear glass partitioning, and the use of filing cabinets, etc., as methods of separating sections were ranked in slightly ascending order but occupied much the same unfavourable position in the ratings. The absence of any physical separation between sections was regarded very unfavourably and ranked last for acceptability.

Table 42
Section clerks replies to questions no 2 to 6

Question number	Question	Replies					
		Definitely Yes	Moderately Yes	Undecided	Moderately No	Definitely No	Total
2	Are the members of a section more aware of themselves as a member of a particular section if they are physically separated from other sections?	14	3	0	2	1	20
3	Is there any tendency for people to be treated less as individuals and more as functionaries in the larger offices?	11	6	0	2	1	20
4	Do you feel that the actual size of clerical areas – that is, the number of people working in any one space – has any real importance from the supervisory point of view?	18	0	0	1	1	20
6	If it was a question of choice, would you choose to have your section located by themselves in a screened off area?	15	2	0	1	2	20
		Large			**Small**		
		Definitely easier	Moderately easier	No difference	Moderately easier	Definitely easier	Total
5	In your experience is it easier or less easy to carry out the specifically supervisory duties of a section which is situated within a large clerical area or a small one?	0	3	1	4	12	20

The results make it clear that the section clerks' preferences are for as much privacy as possible for their sections.

Questions 2 to 6 sought section clerks' views on other aspects of space division. The frequency with which the respondents selected particular categories of answer to explain their attitude is given in table 42.

The results are quite clear and demand no statistical treatments. They represent consistently favourable beliefs about the personal and supervisory consequences of working in small and separate units.

Section clerks selected the statements composing the attitude scale to office size with the frequencies given in table 43 and they may be ranked as shown.

Table 43
Rank order of section clerks response to attitude scale

Rank order	Statement	Frequency chosen
1	The larger offices make one feel relatively unimportant	16
2	The large office creates less feeling of permanence and security than a small one	12
3	There is an uncomfortable feeling of being watched all the time in a large office	10
4	The social life of a large office is likely to be better than that of a small one	9
5	Any disadvantages of the larger office are offset by greater advantages	4
6	A good working atmosphere is more likely to be found in a large office than a small one	3
7	The size of the office itself is not really important	2
	A large office is definitely better to work in than a small one	2

Taken in the aggregate, the pattern of response of each individual displays a generally held and strongly unfavourable attitude towards the open plan.

Question 8 was an entirely open question which sought an elaboration of the replies made to the previous questions, and also for any other comment the respondent wished to make.

The predominant comment made was that it is, or would be, easier to create an 'esprit de corps', 'good morale' or 'sense of belonging' in the smaller office area. Comments of this sort occurred in 60 percent of cases. The difficulty of keeping track of the whereabouts of staff in the large area was mentioned only slightly less frequently, ie, in 55 percent of cases.

Most of the comments made are summarized in this single reply:

> '(I would) strongly advocate the use of full partitioning between sections as it eliminates extraneous noise, ensuring greater concentration on one's work. Smaller units have the effect of people understanding each other as individuals and fosters a better team spirit. In a large unit the tendency is for people to wander off to chat with friends on another section whereas in a small unit, it demands a little more courage and is a more positive action to walk out of the unit for other than recognised reasons'.

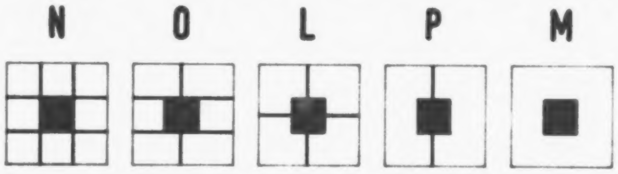
Table 44 summarizes the results for the paired comparison study of office layout preferences, and shows the frequency with which the office layout designated at the column head was preferred to the layout designated by the row.

Table 44
Section clerks: results of paired comparison study of office layout preferences

	L	M	N	O	P	Totals
L		3	15	16	4	38
M	17		16	17	16	66
N	5	4		4	5	18
O	4	3	16		5	28
P	16	4	15	15		50
Totals	42	14	62	52	30	200
Preferred rank order	3	5	1	2	4	

$n = 20$

A simple expression of the preferred order, reading from left to right, is for the area divided in the following ways:



The replies thus show a consistent preference for the smaller partitioned area over any larger grouping.

Summary of results

To summarize the results for this part of the investigation, it was found that a strongly unfavourable attitude existed amongst the supervisors towards the open plan office. The replies to every one of the questions supported this view. A discussion of why this should be so, how the results relate to those of the clerks and managers, and the implications for the hypothesis tested, will be postponed to the conclusions at the end of the appendix.

PART THREE: MANAGERS

Hypothesis to be tested

Like the questionnaire addressed to section clerks, the one addressed to managers was intended to serve the dual purposes of assessing the degree of approval felt towards open office planning and of establishing what were felt to be the relative advantages and disadvantages of open plan design. The information was also required to make comparisons between the attitudes and requirements of managers, supervisors and clerks, with a view to establishing the various factors involved in drafting user requirement reports.

The general hypothesis, relating to the findings of each of the three parts of this appendix, is that differences will exist, and that these differences will depend upon the respondent's functions, expectations, and experience. In the case of managers, the general impression gained from them in the course of interviews and conversations was that, because of the organizational flexibility allowed by the open plan, it had considerable advantages over a number of smaller offices. There were, however, some reservations about the advantages to be gained from having a completely open plan as it was felt that too large an area could be overwhelming for the person working on it.

The single hypothesis to be tested may therefore be formally stated as follows:

Hypothesis: Managers will tend to prefer a small number of open office areas to a larger number of smaller ones.

Population and sample used

The personnel selected to take part in this study were senior executives of the company, all of whom had management responsibilities. They were selected on a random basis from the list of suitably qualified individuals. Fifteen such people were involved in the study, being a one in four sample. All of the subjects were male as no women are employed at managerial level.

The only exception to the random choice of the sample was the deliberate inclusion of the three managers who work on the floor on which the rest of the investigation was conducted and who are responsible for the personnel taking part in the previous two parts of the investigation described in this appendix. The inclusion of their views and attitudes was felt to be especially appropriate.

Method of investigation

The method of investigation for this part of the study was exactly similar to that described for the section clerks in Part Two. A different questionnaire was sent out (Supplement 6), and a different covering letter from the experimenter (Supplement 5), but nothing else was in any way different.

Construction of the questionnaire

The questionnaire to managers is basically similar to the one to section clerks insofar as it is concerned primarily with the effect of room size on the respondent's professional functions, and to a lesser extent with personally held feelings. It would not be expected that people would be able to divorce one from the other entirely, but the instructions with the questionnaire asked the respondent to make every effort to answer the questions strictly in terms of management considerations. Scope for personal feelings was specifically allowed for by the inclusion of the attitude scale used in the other questionnaires, the rationale and construction of which is described in Part One of this appendix.

Question 1 called for a direct ranking of four methods of dividing a large office area, ranging from the completely open to the extensively divided. Question 2 required the manager to assess the optimum size for a general office on the separately presented criteria of morale and productivity; five arbitrary unit sizes were presented as a checklist. Question 3, which had also been included in the section clerks' questionnaire, asked for an assessment of whether people working in large offices tended to be treated more as functionaries and less as individuals. Each of the three questions is empirical in nature and, having face value only, requires no special techniques for construction.

As the managers might be expected to be the most verbally fluent of the groups covered by the present section, and as each must perforce have devoted a certain amount of thought to the layout of his department, two completely open-ended questions (questions 4 and 5) were included. These called for summaries of the managerial advantages and disadvantages of the open plan office. Question 7 was another open-ended question. It was provided to enable the respondent to elaborate on his replies to the other questions and also for him to make any other comment, from a non-managerial point of view, on the influence of the size of office areas.

Results

Question 1 presented the respondent with the following problem, and asked for the answer to be presented in the following way:

> 'If you were asked to plan your department again from scratch, and were applying only the criteria of efficiency and productivity, which of the following alternative arrangements would be your first choice, second, and so on. The alternatives are conceived as referring to general clerical tasks, but exclusive of typing pools and machine areas which present special problems.
>
> Please put a "1" in the box beside your first choice, a "2" beside your second choice, and so on.'

For the purpose of summarizing the results, the numbers signifying the order assigned to each alternative were summed; this yielded a convenient index for ranking the items. A low score against an alternative will therefore mean that the rank order of the various rankings has tended to be high; thus the lower the ranking index the higher the rank order.

The alternatives were ranked as follows:

Table 45

Rank order of managers' preferences of size of clerical working area

Rank order	Type of layout	Ranking index
1	Open general clerical area but some separate managerial and specialist offices	19
2	A moderate amount of partitioning to produce rather smaller clerical areas	27
3	Completely open office space for the whole department without even private offices	50
4	A complex of small work cells – perhaps with each containing a single section	54

The rankings show that the open clerical area with some separate managerial and specialist offices was by far the most preferred alternative. This is in fact the system being operated by each of the respondents at the present time. A moderate amount of partitioning was the next most acceptable alternative, but the very different alternatives of completely open office and complex of small ones appeared to be almost equally unattractive.

The problem posed by question 2 in the questionnaire was:

> 'Other things being equal, in which size of general office would you expect to find the best morale, and from which would you expect the highest relative productivity?'

Five office sizes were offered, together with a rejection clause and were selected with the frequencies shown in table 46.

Table 46

Rank order of managers' expectation of size of general office producing best morale and high productivity

Rank order	Office size	Frequency chosen for morale	Frequency chosen for productivity
1	40 to 60 persons	5	6
2	60 to 100 persons	4	4
3	20 to 40 persons	3	2
4	10 to 20 persons	1	1
5	100 or more persons	1	
–	Size of work unit not relevant to questions	1	1

It can be seen that there was no difference between the ranked order of the alternatives for morale and productivity, though their frequency of choice is slightly different. Indeed, apart from only two exceptions, all the respondents ranked morale and efficiency together in respect of a given office size. One manager rejected the connection of either with room size, but the results show the strong tendency on the part of his colleagues to perceive a connecting link between morale, efficiency, and a given size of working group.

The picture of preferences presented is not clear, in the sense that it does not indicate a trend from small to large or vice versa. However, the majority of the choices, for both morale and productivity, were directed at the two categories of office size containing between them 40 to 100 persons. This, then, would seem to be the optimum size by a majority vote.

In reply to question 3, 'Is there any tendency for people to be treated less as individuals and more as functionaries in larger offices?' the distribution of replies was as follows:

Definitely Yes	Moderately Yes	Undecided	Moderately No	Definitely No
2	3	0	3	7

The results support the general proposition that people are not treated less as individuals in the larger offices but as five of the replies, which represent a third of the sample, were of the opposite opinion, a good measure of dissension must be noted as existing.

Question 4 was a completely open one which called for a summary of the managerial advantages of the open-plan type of office.

The number of reasons given in response to this question averaged 3.5 per person, comparing very favourably with the number of reasons and comments given to questions 5 and 7 which averaged only 1.8 and 2.0 per person respectively.

The following nine advantages of open-planning were extracted:

(i) Easier overall supervision as all staff are normally in the view of the supervisor
(ii) Greater economy and flexibility of space
(iii) Facilitates transfer of work and staff between sections
(iv) Most common records can be kept within the one area thus reducing excuses to leave room
(v) More opportunity for better type staff to become acquainted with all aspects of office routine
(vi) Better layout of the sections permitted
(vii) Uniform standards of discipline can be operated, and be seen to operate
(viii) Wasted journeys can be saved if one can see whether someone is at their desk or not
(ix) Office maintenance and cleaning is simple and cheaper

Question 5 was the converse of the previous one and called for a summary of the managerial disadvantages of the open-plan office.

The interpretation of any such question can only be done impressionistically. A frequency ranking can seldom be applied rigorously because of the way in which a number of fairly similar statements nevertheless express subtle, and sometimes vital, differences. In this case many of the replies were similar but to sum and rank them would be to give a spurious degree of accuracy to findings. Instead, four statements are quoted, direct from the reply forms, as being representative of widely held views. Of these, the first one expresses the most frequently stated opinion:

(i) There are too many distractions with so many people, and any distraction affects larger numbers
(ii) A friendlier group work more usefully and a vast plan doesn't promote this, only pockets of friends who are a distraction to all others when it is their turn to relax and chat
(iii) The morale of the more ambitious staff tends to be lowered by the absence of visible 'status' symbols and a feeling that their qualities will be submerged in the unidentifiable mass surrounding them. This could mean the loss of some of the better staff
(iv) Managers tend to become involved in routine matters, particularly those relating to staff.

The statements comprising the attitude scale to office size were selected with the following frequencies and may be ranked as in table 47.

Table 47
Rank order of managers' response to attitude scale

Rank order	Statement	Frequency chosen
1	Any disadvantages of the larger office are offset by greater advantages	9
2	The social life of a larger office is likely to be better than that of a small one	8
	The size of the office itself is not really important	8
4	A good working atmosphere is more likely to be found in a large office than a small one	7
5	There is an uncomfortable feeling of being watched all the time in a large office	4
6	The larger offices make one feel relatively unimportant	3
	A large office is definitely better to work in than a small one	3
8	The large office creates less feeling of permanence and security than a small one	2

Taken in the aggregate, the pattern of response of each individual represents a moderately favourable attitude on the part of managers towards the open plan office.

Question 7, like questions 4 and 5, was completely open. It drew attention to the restrictions imposed by the specific nature of the previous questions, and invited elaboration of any of the replies given. It also invited the respondent to comment on the problem of the closed versus the open plan office from a point of view other than the managerial one.

Most of the answers given were variations of the advantages or disadvantages of the open office which have already been summarized for questions 4 and 5. The range of the additional comments was therefore rather restricted but the sentiment expressed most frequently was the one crystallized in the following quotation from a reply form:

> 'The calibre of the manager is more important in determining the attitude of the staff to their job than is the size of office'.

This gives, perhaps, a clue to a puzzling result in the response to question 6 where, although the statements selected in the attitude scale were predominantly favourable to large offices, the statement that 'the size of the office itself is not really important' was ranked in joint second place. It seems therefore that the manager regards office size as a factor very much subordinate to the quality of the management and supervision.

The question of the effects upon the individual of working in a large office area produced two distinct points of view. The first saw the open plan as a possible threat to the individual; the second either saw no such threat or saw only positive personal advantages. The following respondent is typical of the minority which saw the open plan as a possible threat to the individual:

> 'Too much emphasis cannot be placed on the vital importance of making every effort to let the staff in an open (and large) office know that they are individuals whose opinions and suggestions for the betterment of the office are both sought and acted upon by the management wherever possible. Without this interest by the management the staff morale and efficiency will deteriorate, and absenteeism increase.
>
> The ideal office area would seem to be one in which about 50 staff are employed, since this number appears to be the maximum capable of assuming an integral identity to which everyone feels they contribute something; and as a result they work in harmony with each other and take pride in the efficiency of their "unit" compared with others. The larger the "unit" the more impersonal does it become and the members tend to belittle the value of their own particular work'.

The following quotation is taken from the reply form of a member of the group who felt that the open plan offers clear psycho-social advantages. The quotation could not be described as typical, but adds a little more to the discussion:

> 'I think large offices can have a "humbling" effect on

> the cocky or pompous but do not necessarily retard the individualist. Indeed, the dominant personality seems to prosper and good examples of dress and behaviour seem to "rub-off" onto the new entrants'.

That the tendency exists for people to prefer smaller areas was referred to, but without it apparently being regarded as a valid determinant of organizational practice:

> 'The "enclosure" system is historical in England and boundaries are often (seemingly inadvertently) marked by clerks themselves in their distribution of office machinery. If no partitioning is provided, and if there is no positive action taken by management, one will often find "fencing" by filing racks. The urge not to get mixed up with other people doing different work is strong I would say in British bones, open plan or not, but I am strongly against people setting up their own shop in too small groups'.

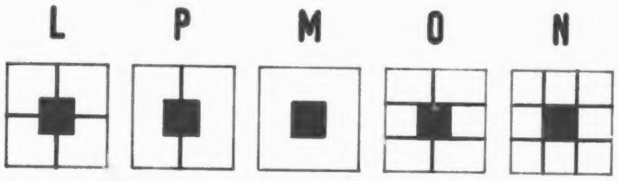
Table 48 gives the results for the paired comparison choices: it shows the frequency with which a given office layout, as designated by the letter at the head of the column, was preferred to the layout designated by the row.

Table 48
Managers: results of paired comparison study of office layout preferences

	L	M	N	O	P	Totals
L		6	1	4	8	19
M	9		4	7	9	29
N	14	11		13	11	49
O	11	8	2		12	33
P	7	6	4	3		20
Totals	41	31	11	27	40	150
Preferred rank order	1	3	5	4	2	

$n = 15$

A simple expression of the preferred order may be schematized as follows, in a descending order of preference from left to right:



Perhaps the most interesting feature of the results is their relationship to those of question 2. The number of people who could work in each of the various office sizes portrayed in the model were, taking the first two rankings, 50 and 100 respectively. This is closely in accord with results of question 2 in which office sizes of between 40 and 100 people were selected by the majority of respondents as promoting the best morale and productivity. The smaller unit sizes were unpopular on both rankings, as were they also unpopular in question 1.

The completely open office was ranked third on the paired comparisons, but fifth when ranked on the criteria of promoting morale and efficiency in question 2. However, in reply to question 1 the completely open office ranked third – almost tying with the small units for fourth (and last) place. The relatively small changes in position are perhaps due to the criteria used for the rankings. But, whatever the explanation of these differences, a moderate amount of partitioning was found to be preferred to either a completely open or a completely closed office plan.

Summary of results
The individual findings of all the questions (except, of course, question 5 which expressly sought the *disadvantages* of open offices) showed that the managers were, as a group, well disposed to large office units, and an extensive list of managerial advantages was put forward in reply to question 4 in support of their view.

However, a smaller number of direct reservations about the completely open office were recorded in reply to question 5 and were implicit in the replies to other questions. In comparing the results of question 8 with those of questions 1 and 2, it was concluded that the managers' position is best reflected by a preference for moderately large rather than very large or very small office areas. Such a conclusion would seem to be congruent with the range of comments made in reply to questions 4, 5 and 7. The discussion of results and their relationship to the hypotheses tested in this, and the other parts composing this appendix, will be treated fully in the conclusions which follow.

CONCLUSIONS

This passage draws together the research findings of the three previous parts of the appendix in order to test the formally stated hypotheses and draw the conclusions from them. Its form is firstly a consideration of the hypotheses and the extent to which they are confirmed by the data; secondly a summary of the findings.

Part one – General clerical workers
Hypothesis 1: The smaller working area will generally be preferred to the larger.

The relevant results for the testing of this hypothesis are those from items two, three and five, all of which provide clear confirmatory evidence.

Item one, the attitude scale, showed that the generally held attitude towards the large open plan office was unfavourable. Additionally, a rank correlation of the order of the statements selected by the clerks as representing their views with the order in which the statements had been ranked by the judges used in constructing the scale, proved to be positively significant. In other words, the trend was for statements which were progressively less favourable to large offices to be progressively more frequently chosen.

Item three, the paired comparison preferences, showed a clear rank ordering of the various sizes of office area in a descending order of preference from the smallest to the largest office sizes.

Item five, the choice of workplace, also showed a clear preference for the smaller size of office.

The results from each of these separate sources yielded the same result: the smaller working area was preferred to the larger. The hypothesis was therefore confirmed.

Hypothesis 2: People working in large open areas will be relatively better disposed towards large areas than those who work in smaller areas.

The data for such comparisons depends upon contrasting the results derived from people working in the three small semi-partitioned areas with those from people working in the remaining open areas. The results bearing on the hypothesis are contained in items two, three and five.

In response to the attitude scale composing item two, it was found that the scale position of the respondents in the smaller areas was very much lower than that of those in the open ones. Both groups held negative attitudes towards large open offices, but the attitude of the people in the small areas was considerably more negative than that of people in the open areas. A chi-squared test was performed on the frequency distribution with which the items composing the scale were checked by the people in each of the two types of area. The respondents from the small areas reported, with a greater frequency than would be expected from the whole table, that the large office makes one feel unimportant, and that it creates less feeling of permanence and security than a small one.

Conversely, respondents in the large areas reported with greater than the expected frequency that a good working atmosphere was more likely to be found in a large office than a small. The differences were significant at the 0.02 level of probability. The conclusion derived in presenting the results of item two was that, though both groups oppose large offices, those working in them were less opposed to them than were those working in small areas.

The results of item three, the paired comparisons, failed to show any such effect. The frequency tables prepared separately for the respondents in large and small areas gave a similar ranked preference of the different office sizes, both consistently preferring the smaller to the larger.

However, the results for item five, the choice of workplace, again revealed a difference in the response patterns of those respondents in the large and those in the small working areas. A chi-squared test of the data revealed significant differences at the 0.05 level of probability. Both groups preferred the two smaller working areas but, of the two, the respondents working in the smaller areas chose the smallest area in the photograph significantly more often than the respondents working in the large areas. The converse also held.

Three sources have been referred to as providing the results against which the present hypothesis can be tested. One only of these, item three, failed to yield any evidence that respondents working in large open areas are comparatively better disposed towards large offices than are respondents from the smaller areas. The result is perhaps not altogether surprising though as both groups were opposed to the large office and, as the differences in their attitudes were ones of degree and not kind, it might be expected that some items would be relatively insensitive in reflecting smaller attitudinal differences. However, as the result of this one item is neutral rather than contradictory to the hypothesis, and as items two and five both yielded positive results, the stated hypothesis is held to be confirmed.

Hypothesis 3: The number of friendship choices made and received between people will be progressively fewer with increased distance.

The totals row of table 31 summarizes all the data necessary to test this hypothesis. The results show a clear trend for the number of socio-preferential choices to decrease with the increase of distance between people. One exception to this was noted and discussed but as this does not appear to contradict the hypothesis, it is therefore held to be confirmed.

Hypothesis 4: The number of inter-section preferences expressed will be greater in the open areas than in the small partitioned ones.

The data needed to test this hypothesis is contained in column 6 of table 33. Of the total number of named preferences given, 64 percent of those made by respondents working in the open areas were made to other members of the same section. Thus 36 percent of the socio-preferential choices must have been directed towards members of some other section. By contrast, 81 percent of choices made by respondents working in the small areas were directed towards members of their own section and thus only 19 percent to members of other sections.

The hypothesis was thus confirmed.

Hypothesis 5: There will be a higher proportion of reciprocal choices in the smaller work areas than in the larger ones, though a greater number of isolates.

Column 8 and 10 of table 33 contain the data necessary to test this hypothesis.

Column 8 shows the number and percentage of reciprocated choices made within a single section, and compares the large open areas with the small. The differences are gross : 38 percent in the large areas compared with 66 percent in the small. The first part of the hypothesis is therefore confirmed.

Column 10 shows the number and percentage of isolates found in the large and small areas. Again, the differences approach the order of 2:1 i.e, 5 percent in the open areas compared with 9 percent in the smaller. The numbers in both cases were small but the differences marked. The second part of the hypothesis was also confirmed, and thus the entire hypothesis as stated.

Hypothesis 6: There will be marked differences between the attitudes of clerks, supervisors and managers to open office planning.

Differences in the attitudes of clerks, supervisors and managers towards open office planning were manifest in all of the results in which comparison is possible. The most direct comparisons may be made with the replies to the attitude scale and paired comparison ranking of preferred office layouts, which were common to all three groups.

In reply to the attitude scale, it was found that the group scale scores of clerks, section clerks and managers were 0.907, 0.750, and 1.307 respectively. The neutral point on the scale was 1.125, and it is clearly apparent that section clerks hold a relatively less favourable personal attitude towards open planned offices than do either of the other groups, and that the attitude of clerks falls within the unfavourable half of the scale whereas the replies of the managers are favourable.

The paired comparison photographs were ranked by clerks and section clerks alike in descending order of preference with increased size of office spaces. Managers differed from both in the form of their replies, opting for moderately large and completely open areas in preference to small ones.

Further differences between the attitudes of supervisors and managers were apparent from the replies to the question of whether it was felt that there was a 'tendency for people to be treated less as individuals and more as functionaries in larger offices'. Seventeen out of twenty section clerks agreed with this statement compared with five out of fifteen managers.

Section clerks opted for small enclosed work units and gave strong supporting reasons. The managers, by contrast, opted consistently for moderately open areas.

In summary, the most marked differences of attitude towards large clerical areas were those between supervisors and managers. However, the attitude of supervisors (as measured by the attitude scale) was shown to be considerably more negative towards large offices than was the attitude of the clerks.

The hypothesis was therefore confirmed.

Part two – Section clerks

Hypothesis: Supervisory staffs will choose to have their own groups separated off from those of other supervisors.

A question asked directly whether supervisors would choose to have sections in separate screened-off areas; the results were strongly in favour of this. Replies to other questions made it clear that the screening of sections was regarded as very desirable and underlined the strong preference of supervisors for small areas rather than large open ones.

The hypothesis was therefore confirmed.

Part three – Managers

Hypothesis: Managers will tend to prefer a small number of open office areas to a larger number of smaller ones.

The most direct confirmation for this hypothesis came from the paired comparison photographs, where the layouts divided into four units of fifty people and two units of one hundred were ranked in first and second places respectively. The completely open plan was ranked in third place; the six-part division in fourth, and the eight-part division in last place.

The attitude scale showed that the managers tended to prefer large office units to small, and the results of other questions showed that their preference was for the medium-large rather than the very large or the very small areas.

The hypothesis was therefore confirmed.

Summary of findings

The broad frame of reference with which this study started was to examine variously the attitudes of clerks, supervisors, and managers to large offices, and to describe some of the objective consequences of different size groupings for the formation of social relationships. It was found that clear differences existed between the attitudes of the various occupational categories. Managers were found to prefer fairly large general offices, whereas clerks preferred small ones, and supervisors were more extreme than the clerks in their preference for small offices and their disapproval of large ones.[44] It was also found that, though both groups of clerks were opposed to large office areas, those in the small ones were much stronger in their opposition than those actually working in them.

The results thus raise an important question from the management or user-requirement point of view of the relative weight to be given to the attitude expressed by the managers, supervisors and clerks. Managers offered good managerial reasons why a course opposite to the course advocated by supervisors should be followed in the division of space and supervisors similarly justified a course opposite to the managers. The attitudes of the clerks must also be given some consideration, if only to ascertain whether to ignore them would have any repercussions in terms of lowered working effectiveness. So far these questions have nowhere been dealt with, though buildings continue to be built, and the decisions concerning the size of working spaces, taken.

The objective consequences of different office sizes are contained in the results of the socio-preferential study. These revealed marked differences in the socio-preferential response patterns of people working in the small semi-partitioned areas and those working in the remaining open areas.

It was found that the pattern of choices depended upon three factors: age, sex and inter-personal distance. The results also showed that people in the larger areas made a greater average number of choices, that very many more of these were directed outside of the section in which they were made, and slightly more went outside of the department. It was also apparent that people in the small areas reciprocated very many more of the choices within their own section, and had fewer reciprocated choices with members of their department other than those in their own section. It was found that there was a higher proportion of isolates in the smaller areas than in the large, though the numbers were small in each case.

The above, then, were the objective differences found to result from locating working sections in large and small areas. The existence of these differences raises the management question of which one is to be preferred. The intra-group cohesiveness of the sections in the small areas meets many of the criteria for small group effectiveness. On the other hand, the sections in the open areas have better interconnections with other parts of the department and may therefore constitute more effective total working units than the sum of individual sections.

The results so far have shown differences in social group formation which have resulted from the conditions provided by the building. To attempt to establish which social or working organization is the most desirable would be to go beyond the scope of the present report and involve considerations wholly divorced from the design problem. Suffice it to say that considerable social consequences have been found to result from different types of space provision, and that these differences justify further investigation of the building as a management tool.

Four main conclusions may be drawn from the results of the study reported in this appendix:

1. Despite any differences in the pattern of results for sub-samples, all groups except managers prefer to have small general clerical areas rather than large ones. This confirms one of the results of the first CIS questionnaire, which is discussed in chapter 10.
2. There is a considerable dissonance between the views of managers, supervisors and clerks as to what constitutes the most satisfactory type of office area. The several bases for these views, and their actual organizational, personal and social consequences, have not yet been the subject of experimental investigations. However, they present problems of considerable consequence and should therefore be assigned a priority in subsequent management and user-requirement studies.
3. The results showed that people working in large open areas are better disposed towards them than are people working in small semi-enclosed ones. This seems to suggest that some form of prejudice is operative such that people are either better disposed towards what is familiar, or less well disposed to what is unfamiliar. On either explanation, the finding conveys the implication for user-requirement studies that they should only be conducted with subjects having first hand experience of the conditions being investigated.
4. Friendship patterns were shown to develop in quite different ways in different types of working area. A working group, housed in a small semi-partitioned area, was found to be more internally cohesive than a similar working group surrounded by others in a large area. Conversely, groups working in the small areas were found to have fewer friendship links with other parts of their department. Such matters are likely to have considerable effects on the working effectiveness of the small and large unit and to have occupational, social and personal consequences for the occupants. It therefore seems that this topic also should be made the subject of further studies in management and industrial psychology.

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[44] It has been said that there is an element of status seeking in the supervisors' desire for small spaces and that they may not like to feel that they are under the direct supervision of a Chief Clerk, though experience has shown that, in the main, such supervision is necessary

Appendix 5.1
Supplement 1

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE: ROYal 6022 Ext. 353

Dear Sir or Madam,

This document is being circulated by staff members of Liverpool University as part of our continuous study of the design of modern office buildings, and with particular reference to user requirements.

The replies to the questionnaire will, of course, be treated absolutely confidentially and dealt with in terms of generalisations, not specific cases. The work is supported both by the management of the CIS and by the Guild, and therefore represents no sectional interest whatever.

We should be very grateful for your co-operation in this study: after all, design is only successful insofar as it meets people's needs and preferences. We are, therefore, once again referring our problem to you as users for assessments of some of the matters we are investigating connected with office planning. Our broad intention is to assess the conditions which your experience indicates lead to the most satisfactory working conditions. We can then relate this information to the technical design problems and attempt to describe the way in which the most favourable working conditions might be created. The precision with which we can attain this goal can, of course, be no greater than the precision with which you complete this document. We therefore hope that you will feel that the trouble involved in making such a careful appraisal will be well worth while in terms of the improved conditions that you are helping to devise, and that you will be kind enough to help us in this way once again.

Yours faithfully,

B. W. P. Wells

Appendix 5.1
Supplement 2

PART ONE

Personal Details - Please put a tick in box beside appropriate reply

Name (Initials)........................... (Surname)..

Sex:	MALE	☐	FEMALE	☐
Grade:	BASIC A	☐	BASIC A	☐
	BASIC B	☐	BASIC B	☐
	GRADE 3	☐	BASIC C	☐
	GRADE 2	☐	MACHINE OPERATOR	☐
	GRADE 2A	☐	TYPIST	☐
	GRADE 1	☐	GRADE 2A	☐
	OTHER (please write)		GRADE 1	☐
			OTHER (please write)	
	....		....	
	....		....	
Age group:	15 - 19	☐	15 - 19	☐
	20 - 24	☐	20 - 24	☐
	25 - 29	☐	25 - 29	☐
	30 - 34	☐	30 - 34	☐
	35 - 39	☐	35 - 39	☐
	40 or over	☐	40 or over	☐

Department..

Name of Section Clerk in charge of your Section..

PART TWO

Spatial Considerations

The following eight statements each refer to the size of general office work areas and to personal feelings about them. The context of these statements is the contrast between the open planning of the general office ('the large office') and *the subdivision of the same area by partitioning* ('the small office'), conceived as being different unit sizes of the same company. 'The small office' may be thought of as containing about 25 people; 'The large office' about 75 people.

Please put a tick in the box next to the statement or statements with which you are in agreement, and a cross beside the statement with which you disagree, thus putting either a tick or a cross against every statement. Will you also put a second tick in the box against the statement with which you feel *most strongly* in agreement, ie, ☑

1. A good working atmosphere is more likely to be found in a large office than a small one. ☐
2. The larger offices make one feel relatively unimportant ☐
3. A large office is definitely better to work in than a small one ☐
4. The size of the office itself is not really important ☐
5. The large office creates less feeling of permanence and security than a small one ☐
6. There is an uncomfortable feeling of being watched all the time in a large office ☐
7. The social life of a large office is likely to be better than that of a small one ☐
8. Any disadvantages of the larger office are offset by greater advantages ☐

PART THREE
Layout Preferences

The pictures that are to be projected each show two alternative layouts of the same office floor area. (*Example*) You will see that one layout is placed above the other and that each has been designated by a letter written below it. In the Reply Section below, will you please draw a ring around the letter for the layout that you feel would be the office arrangement in which you would prefer to work.

(*Example*)	[✓ X] Y

The choice may sometimes be difficult to make, but please try to make one for every case.

Reply section

Slide 1	O P	Slide 6	N L
Slide 2	L M	Slide 7	M O
Slide 3	N M	Slide 8	P L
Slide 4	L O	Slide 9	M P
Slide 5	P N	Slide 10	O N

PART FOUR
Social Considerations

From the individual's point of view, no less important than occupational satisfactions are the social ones. It therefore follows that good working area design should also meet legitimate social needs. These needs are served in different ways by different spatial arrangements, and it is the purpose of this part of the study to get some information about this.

One way of getting a 'bird's-eye view' of the social climate of an organisation is in terms of what is known as *sociometry*. The method is simply to ask all the members of a given group to specify those other members of the group with whom they are particularly friendly.

We appreciate that this information is rather more personal than that which is normally asked for, but our justification for asking must be that the information is valuable and will be of practical use to the planning of new office blocks. Once more we should like to stress that these documents are absolutely confidential. *The contents will be available to absolutely no one on the staff of the CIS, and the completed document will be collected personally by a member of the University Staff. The data will be used for statistical generalisations only and once it has been coded and transferred to punched cards, the questionnaire will be immediately destroyed.*

For the present study we should like you to list, in order of preference, those people *who also work on the floor*, * whom you would like to work close to. There is no question of any action resulting from these choices: they will only be used to test certain theories about work satisfaction.

Absolutely confidential

Order	Surname	Christian name	Mr/Mrs/Miss
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

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*Floor specified on original

Additional Information

Do you have any particularly good friends or acquaintances on other floors? If so, would you be so kind as to mark the number in the boxes beside the floors.

	Number
1. *	☐
2. *	☐
3. Fifth to tenth	☐
4. Eleventh to twenty-second	☐

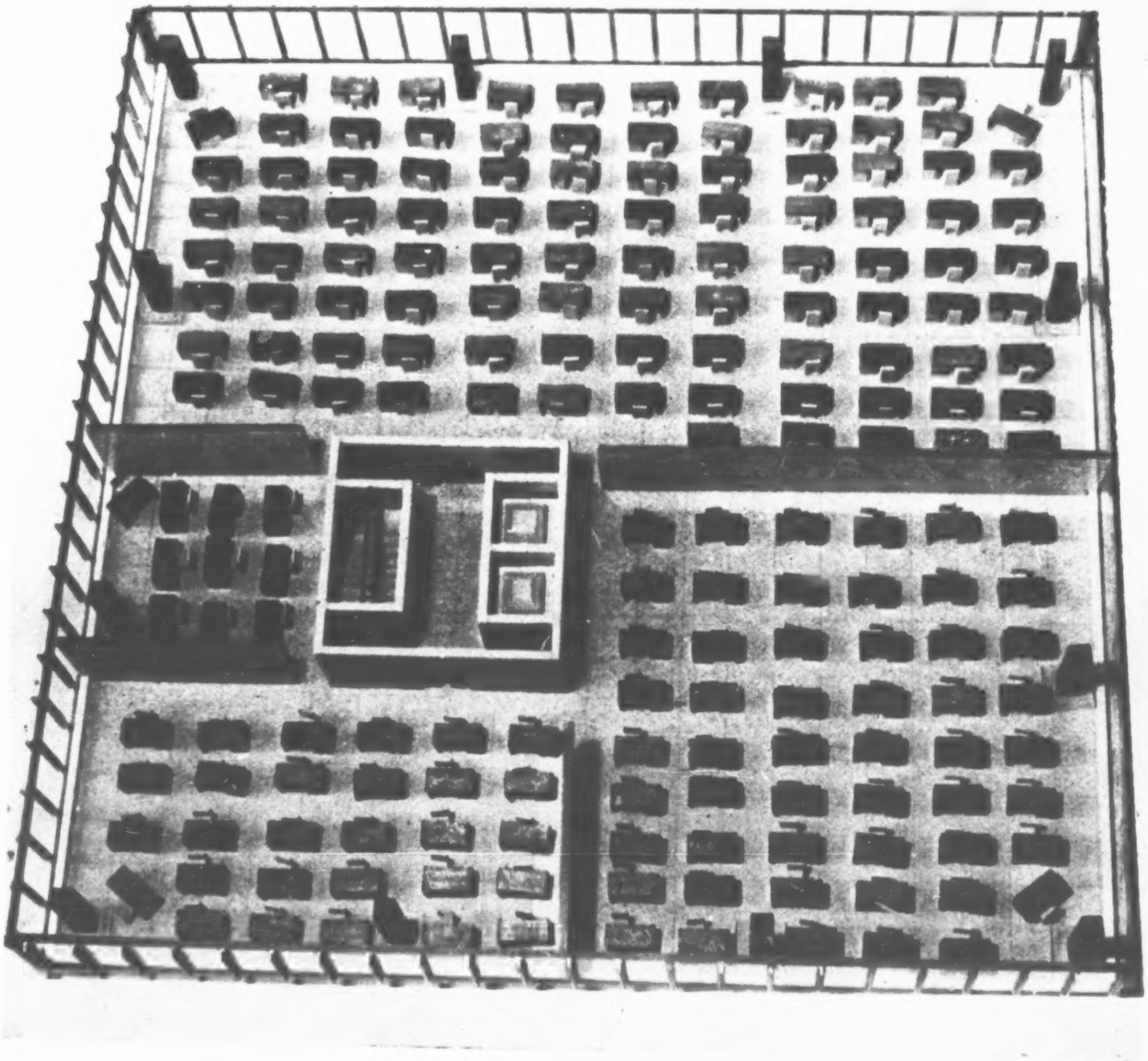
* Floors specified on original

PART FIVE

(*Show slide*) As you can see, this slide is a model of an office layout partitioned in various ways (indicated). The model is meant to resemble the CIS building in general terms, having permanent supplementary lighting and air conditioning.

Will you please try to imagine that you are going to work somewhere in this office and that you have complete freedom to choose your own work place (with the exception of the supervisor's desks which face into the room – indicated).

On the print of this slide which is given below, please put a bold 'X' on the desk position at which you would choose to work.



Please state reasons for choosing your work place ....
....
....
....
....

Appendix 5.1
Supplement 3

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE: ROYal 6022 Ext. 353

QUESTIONNAIRE TO SECTION CLERKS

Dear Mr

We are, in the Department of Building Science at the University of Liverpool, still looking intensively at the question of the design of modern office buildings. Our concern is particularly with user requirements, and at the present time specifically with the way in which the interior layout of the building affects the supervision of working groups, and here we are thinking in terms of comparisons between large clerical areas of 75 or more persons in any open unit and smaller areas of about 25 people.

At the present time there is very little information about the effects of large open plan offices compared with smaller areas on the work of section heads. It may prove to be a consideration of either fundamental or slight importance, but however high or low it comes in the scale of environmental needs, one wants to be clearly aware of the advantages or penalties involved.

In considering your replies it would be very much appreciated if you would give them careful attention and try to tick the box which exactly fits your opinion, as the issues involved also affect such other matters as lighting, ventilation, circulation spaces, structural form, and a host of others. It therefore follows that a reply which is either favourable or unfavourable to a given arrangement should be seriously held in terms of your working experience. Almost any arrangement can be allowed for, but the data we need is about the actual supervisory consequences. After all, the building is not an end in itself, but a means to an end, and that end is to produce the most suitable working arrangement possible.

The replies to the questionnaire will, of course, be treated confidentially and dealt with in terms of generalisations, not specific cases. As you are no doubt aware, the work is supported both by the Management and the Guild, and therefore represents no sectional interests. The purpose is to assess the conditions which your experience indicates leads to the most satisfactory conditions for work. We then have the problems of design to consider in order to optimise physical conditions in the light of your experience. The precision with which we can obtain this goal can, of course, be no greater than the precision with which you complete this document, and we therefore hope that you will be kind enough to give us this help once more.

Yours sincerely,

B. W. P. Wells

P.S. The final section of the questionnaire cannot be completed at this stage as the slides to be shown with it will not be presented until the coffee room session. Perhaps, therefore, you would be kind enough to complete the questionnaire as far as possible and bring the whole thing along with you to the coffee room.

Appendix 5.1
Supplement 4

Will you please make the effort to think about the problem *strictly* in terms of supervisory considerations, rather than such connected ones as the general level of office noise, ventilation and lighting; matters which will receive separate attention. As with the other questionnaires you have been kind enough to complete, we should be very grateful if you would avoid discussing the questions until after you have returned the questionnaire.

(*Please place a tick in the box below the statement which most exactly represents your opinion for each of the alternatives*).

1. Assuming that a large office space was provided for say 4 to 6 sections totalling perhaps 100 to 150 people, how would you rate the following types of arrangement:

(i) Sections not physically separated from one another	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐
(ii) Five-foot high panel partitioning between sections	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐
(iii) The use of filing cabinets, telephone and postal tables, etc as the boundaries between sections	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐
(iv) Floor to ceiling panel partitioning between sections	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐
(v) Wide gangways separating sections	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐
(vi) Clear glass partitioning between sections	Very favourably ☐	Moderately favourably ☐	Indifferent ☐	Moderately unfavourably ☐	Very unfavourably ☐

2. Are the members of a section more aware of themselves as a member of a particular section if they are physically separated from other sections?

Definitely Yes ☐	Moderately Yes ☐	Undecided ☐	Moderately No ☐	Definitely No ☐

3. Is there any tendency for people to be treated less as individuals and more as functionaries in the larger offices?

Definitely Yes ☐	Moderately Yes ☐	Undecided ☐	Moderately No ☐	Definitely No ☐

4. Do you feel that the actual size of clerical areas – that is the number of people working in any one space – has any real importance from the supervisory point of view?

Definitely Yes ☐	Moderately Yes ☐	Undecided ☐	Moderately No ☐	Definitely No ☐

5. In your experience is it easier or less easy to carry out the specifically supervisory duties of a section which is situated within a large clerical area or a small one?

LARGE			SMALL	
Definitely Easier	Moderately Easier	No Difference	Moderately Easier	Definitely Easier
☐	☐	☐	☐	☐

OR

No satisfactory basis for decision ☐

6. If it was a question of choice, would you choose to have your section located by themselves in a screened-off area?

Definitely Yes	Moderately Yes	No Preference	Moderately No	Definitely No
☐	☐	☐	☐	☐

7. **Spatial Considerations**

The following eight statements each refer to the size of general office work areas and to personal feelings about them. The context of these statements is the contrast between the open planning of the general office ('the large office') and the *subdivision of the same area by partitioning* ('the small office'), conceived as being different unit sizes of the same company. 'The small office' may be thought of as containing about 25 people; 'The large office' about 75 people.

Please put a tick in the box next to the statement or statements with which you are in agreement, and a cross beside the statements with which you disagree, thus putting either a tick or a cross against every statement. Will you also put a second tick in the box against the statement with which you feel *most strongly* in agreement, ie, ☑

A good working atmosphere is more likely to be found in a large office than a small one ☐
The larger offices make one feel relatively unimportant ☐
A large office is definitely better to work in than a small one ☐
The size of the office itself is not really important ☐
The large office creates less feeling of permanence and security than a small one ☐
There is an uncomfortable feeling of being watched all the time in a large office ☐
The social life of a large office is likely to be better than that of a small one ☐
Any disadvantages of the larger office are offset by greater advantages ☐

8. The questions included in this questionnaire were, necessarily, somewhat arbitrary and limiting in their freedom of personal response. It would however be exceedingly helpful if you would comment on any matters arising from the supervisory problems of the open compared with the smaller office plan. Elaboration of your replies to questions in the questionnaire would be very welcome, as would your comment on the size of office areas from a point of view other than the supervisory one.

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PLEASE IGNORE THIS SECTION FOR THE TIME BEING BUT BRING IT ALONG, TOGETHER WITH THE COMPLETED QUESTIONNAIRE TO THE COFFEE ROOM SESSION

OFFICE LAYOUT PREFERENCES

9. The pictures that are to be projected each show two alternative layouts of the same office floor area. (*Example*) You will see that one layout is placed above the other and that each has been designated by a letter written below it. In the Reply Section below, will you please draw a ring around the letter for the layout that you feel would be the office arrangement which you tend to recommend if there were no organisational objections to any of them.

(*Example*) [✓ X] Y

Full air conditioning is envisaged, together with evenly distributed permanent illumination from ceiling mounted fluorescent fittings.

The choice may sometimes be difficult to make, but please try to make one for every case.

Reply Section

Slide 1	O	P	Slide 6	N	L
Slide 2	L	M	Slide 7	M	O
Slide 3	N	M	Slide 8	P	L
Slide 4	L	O	Slide 9	M	P
Slide 5	P	N	Slide 10	O	N

Appendix 5.1
Supplement 5

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE: ROYal 6022 Ext. 353

QUESTIONNAIRE TO MANAGERS

Dear Mr

As you will no doubt be aware, the survey of environmental conditions that we of the University of Liverpool have been making at the CIS since the summer of 1962 is still continuing. The brief questionnaire attached to this letter is one of the concluding items of the project and is concerned with one of the most fundamental matters in office layout design, the relative merits of the open plan and the smaller unit office.
The relative merits of the two competing layout plans will, of course, depend upon the point of view from which they are judged. We have sought other points of view and now need to know the answers to some questions related to productivity and man management. The only way we can get these answers is by referring them directly to you, and we therefore hope that you will be kind enough to give us this help.

Yours sincerely,

B. W. P. Wells

P.S. The final section of the questionnaire cannot be completed at this stage as the slides to be shown with it will not be presented until the coffee room session. Perhaps, therefore, you would be kind enough to complete the questionnaire as far as possible, and bring the whole thing along with you to the coffee room.

Appendix 5.1
Supplement 6

Except where otherwise specifically requested, will you please make the effort to think about the problem *strictly* in terms of management considerations, rather than such connected ones as the general level of office noise, ventilation and lighting; matters which will receive separate attention. As with the other questionnaires you have been kind enough to complete, we should be very grateful if you would avoid discussing the questions until after you have returned the questionnaire.

1. If you were asked to plan your department again from scratch, and were applying only the criteria of efficiency and productivity, which of the following alternative arrangements would be your first choice, second, and so on. The alternatives are conceived as referring to general clerical tasks, but exclusive of typing pools and machine areas which present special problems.
Please put a '1' in the box beside your first choice, a '2' beside the second choice, and so on.

	Rank
(a) Completely open office space for the whole department without even private offices	☐
(b) Open general clerical area but some separate managerial and specialist offices	☐
(c) A moderate amount of partitioning to produce rather smaller clerical areas	☐
(d) A complex of small work cells – perhaps with each containing a single section	☐

2. Other things being equal, in which size of general office would you expect to find the best morale, and from which would you expect the highest relative productivity?

	Please tick for morale	**Please tick for productivity**
10 – 20 persons	☐	☐
20 – 40 persons	☐	☐
40 – 60 persons	☐	☐
60 – 100 persons	☐	☐
100 or more persons	☐	☐
Size of work unit not relevant to questions	☐	☐

3. Is there any tendency for people to be treated less as individuals and more as functionaries in the larger offices?

Definitely Yes	Moderately Yes	Undecided	Moderately No	Definitely No
☐	☐	☐	☐	☐

4. Can you please summarise the managerial *advantages* of the open-plan type of office:

....

....

....

....

....

....

5. Will you please now summarise the managerial *disadvantages* of the open-plan office:

....

....

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6. **Spatial considerations**

The following eight statements each refer to the size of general office work areas and to personal feelings about them. The context of these statements is the contrast between the open planning of the general office ('the large office') and *the subdivision of the same area by partitioning* ('the small office'), conceived as being different unit sizes of the same company. 'The small office' may be thought of as containing about 25 people; 'The large office' about 75 people.

Please put a tick in the box next to the statement or statements with which you are in agreement, and a cross beside the statements with which you disagree, thus putting either a tick or a cross against every statement. Will you also put a second tick in the box against the statement with which you feel *most strongly* in agreement, ie, ☑

A good working atmosphere is more likely to be found in a large office than a small one ☐
The larger offices make one feel relatively unimportant ☐
A large office is definitely better to work in than a small one ☐
The size of the office itself is not really important ☐
The large office creates less feeling of permanence and security than a small one ☐
There is an uncomfortable feeling of being watched all the time in a large office ☐
The social life of a large office is likely to be better than that of a small one ☐
Any disadvantages of the larger office are offset by greater advantages ☐

7. The questions included in this questionnaire were, necessarily, somewhat arbitrary and limiting in their freedom of personal response. It would however be exceedingly helpful if you would comment on any additional matters arising from the management problems of the open compared with the smaller office plan. Elaboration of your questions in the questionnaire would be very welcome, as would your comment on the size of office areas from a point of view other than the managerial one.

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PLEASE IGNORE THIS SECTION FOR THE TIME BEING BUT BRING IT ALONG WITH THE COMPLETED QUESTIONNAIRE TO THE COFFEE ROOM SESSION

OFFICE LAYOUT PREFERENCES

8. The pictures that are to be projected each show two alternative layouts of the same office floor area.

(*Example*) You will see that one layout is placed above the other and that each has been designated by a letter written below it. In the Reply Section below, will you please draw a ring around the letter for the layout that you feel would be the office arrangement which you tend to recommend if there were no organisational objections to any of them.

(*Example*) [✓ X]
Y

Full air conditioning is envisaged, together with evenly distributed permanent illumination from ceiling mounted fluorescent fittings.

The choice may sometimes be difficult to make, but please try to make one for every case.

Reply section

Slide 1	O P	Slide 6	N L
Slide 2	L M	Slide 7	M O
Slide 3	N M	Slide 8	P L
Slide 4	L O	Slide 9	M P
Slide 5	P N	Slide 10	O N

Appendix 6.1
Surveys of daylight in offices

In spite of the difficulties mentioned in chapter 6, measurements of daylight factor were made in two office buildings: in two rooms on the fifteenth floor of a side-lit building and over a representative area of an extensive, open-plan, top-lit, single-storey office building.

The instrument used was a BRS EEL daylight factor meter. This includes two photocells, the 'indoor' cell being cosine corrected and the 'outdoor' reference cell enclosed in a blackened tubular shield. The 'outdoor' cell was placed on the roof of the building and elevated at an angle of 42° from the horizontal. (For a CIE sky the luminance at this altitude is numerically equal to the total illumination on an unobstructed horizontal plane).

The indoor cell was placed in the centre of the working area of each desk in the room or area surveyed.

Measurements in the side-lit office were made on one day and repeated on the next. The sky was completely overcast during the time of both surveys. In spite of the apparently similar sky conditions, the daylight factors at the same position differed from one day to the next (table 49).

Table 49
Daylight factors in one office measured on two successive days

daylight factor (percent)

Date	Desk no.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
29th January	8.0	8.0	6.9	6.9	5.6	9.8	8.8	2.6	2.7	2.7	2.6	2.0	2.8	2.7
30th January	7.0	6.4	5.6	5.5	4.7	8.2	7.4	2.8	2.0	2.1	1.9	2.6	2.5	2.3

		Commence		**Finish**
Sky luminance at 42° from horizontal	29th January	200	to	260 ft.-L
	30th January	320	to	400 ft.-L
Average daylight factor	29th January—4.8 percent			
	30th January—4.1 percent			

To compute the daylight factors which would be obtained under a CIE sky, a detailed record of the actual sky distribution should be obtained. However, for such steps to be worthwhile the sky luminance distribution must be recorded at the same time as the measurements are taken and this was not possible in this survey.

Only one set of measurements was made in the single-storey office building. The average of seventy-one readings of daylight factor was 4.6 percent and the range 2.4 to 8.2 percent. The readings were taken in the afternoon of 3rd March 1963; during the period in which measurements were made the sky luminance varied between 600 and 680 ft.L.

Appendix 6.2
Surveys of electric light in offices

Surveys of electric lighting were made in six offices. A typical floor, or section of a floor, of a building was chosen; the colours and condition of the floors, walls, ceilings and desks were noted, and in some cases their reflectivities were measured. The position, type and condition of the lamps were noted and the room dimensions (including its height) and the positions of desks, were measured.

Illumination surveys were made when the external illumination did not exceed one lm./sq.ft. A portable photoelectric photometer (an EEL 'Lightmaster') was used. The cell is cosine and colour corrected but the measurements obtained must be multiplied by a correction factor which depends on the type and colour of the lamps. Where there was more than one colour of lamp in a surveyed area, the number of lamps of each colour was counted and a weighted average value of the correction factor adopted. The photocell was placed in the middle of the working area of each desk top and the value of illumination at that point read from the meter. All the offices except one were unoccupied when the measurements were taken. In the one office where people were seated at their desks they were asked not to lean over the cell.As the lighting installation in this building produced an even and fairly shadow-free illumination, the reduction caused by the shadowing effect of the people was probably small; a comparison of individual results for occupied and unoccupied desks indicated that it was about 4 percent of the average.

Measurements of surface reflectivities were made using a reflectometer designed by the Paint Research Station. This has a photocell with a hole in the middle through which a beam of light from a small lamp is directed onto the specimen, which then reflects the light back to the cell. The test head was first placed on a freshly prepared surface of magnesium carbonate and the meter calibrated to this basis. The head was then placed on the specimen and the meter deflection noted. Several readings were taken on each surface and the average values found.

In some cases it was not possible to measure ceiling reflectivities without a great deal of difficulty, and estimates were made with the aid of shade cards of known Munsell value. To assess the accuracy of these estimates, the reflectivities of several test surfaces were estimated and then checked by measurements. The estimated values were within 15 percent of the measured values.

Appendix 6.3
Scale for estimating relative percentage of daylight and electric light used in experimental study of satisfactory lighting conditions for clerical workers

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE : ROYal 6022 Ext. 353

As illumination plays such an important part in clerical work, we are especially concerned with its evaluation. The next item is particularly difficult, estimating the amount of illumination due to daylight sources and the amount due to electric lighting. Please attempt this judgement even though you may find it very hard.

Holding the sheet of paper flat on the desk, will you please try to estimate the relative amounts of daylight and electric light illuminating it.

The following scale is marked from 0 – 100% of daylight. Will you please put a cross on the scale at the appropriate point.

PERCENTAGE OF DAYLIGHT

No daylight: entirely electric light 0% 10 20 30 40 50 60 70 80 90 100% **All daylight: no electric light**

Floor ....
Position ....
Meter reading ....

Appendix 7.1
Surveys of the thermal environment in offices during winter

Surveys of the winter thermal environment were made within the offices of six organisations (in five buildings). The purpose was to learn how closely modern office buildings provide the standards of thermal environment currently recommended.

Wherever possible measurements were made in large open-planned offices, but the areas of buildings chosen did not always cover a whole floor. The areas surveyed amounted to about 7,000 sq.ft in the airconditioned offices and 3,000 to 4,000 sq.ft in the naturally ventilated offices.

In each office building between 16 and 20 globe thermometers were positioned so that conditions representative of the occupied zones could be measured. The usual arrangement was to place the globes in rows across the building at a spacing of between 8 and 16 feet. An exactly symmetrical layout on a grid was never possible because of the placing of the desks.

The globe thermometers were located 4ft above the floor because this is about head-height for seated office personnel. Previous research workers have taken temperature measurements at various heights ranging from 2ft 6ins to 5ft.[1,2,3,4] The measurements of air temperature, relative humidity and air movement were made at approximately the same height as the measurements of globe temperature. Measurements of air movement were made with kata thermometers and were extremely time-consuming, so that they could be made only a few times a day. Air and globe temperatures and relative humidity were measured at the same time as air movement and intermediately. The majority of readings were taken between 1020 and 1140 hours and between 1420 and 1540 hours.

Vertical air temperature gradients were measured in four buildings having different systems of heating. The measurements were made with a portable, manually-balanced potentiometer and thermocouple.

Records of the external climate were obtained from the nearest meteorological stations. Three offices are located in a city centre within two-fifths of a mile of a meteorological station whose instruments are sited on the roof of a city building; another office is situated in a suburb of a large provincial city, within one mile of another meteorological station. The meteorological data for these four offices should therefore be reasonably representative of the climate around them. The nearest meteorological station to the two other offices is six miles distant. Since the offices are in a city centre, some differences between the readings obtained from the station and the actual values around the building are certain.

These surveys of winter thermal conditions were made during an extended spell of cold weather in the first three months of 1963.

---

1. **Hickish, D. E:** Thermal sensations of workers in light industry in summer. J Hygiene, 1955, 53 (1)
2. **Black, F. W:** Desirable temperatures in offices. J Inst Heat Vent Engrs. 1954, 22 (11).
3. **Bruce, W:** Man and his thermal environment. Technical paper no. 84 of the Division of Building Research, (NRC 5514). National Research Council (of Canada). (The Council) Ottawa, 1960 (February)
4. **Institution of Heating and Ventilating Engineers:** Guide to current practice. London (The Institution), 1959

Appendix 7.2 Surveys of the thermal environment in offices during summer

Surveys of the thermal environment were made during the summer of 1963 within three buildings. The method of measurement was the same as that already described in appendix 7.1 for winter thermal surveys. Records of the external climate were obtained in the same way as those described in appendix 7.1.

Summer thermal surveys were restricted to days when the meteorological stations forecast sunny conditions with shade air temperatures of 70°F or higher. Unfortunately, there were only two warm spells in the summer of 1963, the first at the beginning of June, the second at the end of July.

Appendix 8.1
Surveys of noise levels in office buildings

Surveys of noise levels were made in a number of offices within nine buildings. The purpose of these surveys was to compare typical noise levels in some provincial office buildings with currently recommended criteria.

The surveys were made in general and private offices, typing rooms, machine rooms, conference rooms and a boardroom. Most of the general offices contained adding machines or typewriters. The number of occupants in the general offices ranged from three up to several hundred; some of the private offices and both the conference rooms and the boardroom were unoccupied. The occupants of the various offices were asked to carry on with their normal duties while the surveys were being made so that the noise levels measured represented the usual conditions. In order that measurements should be representative of normal conditions, they were made only during the middle of the morning and the middle of the afternoon. Peak traffic periods were avoided.

The instrument used was a Bruel and Kjaer precision sound level meter and octave filter set. A condenser microphone was used with the meter. The meter was supported on a tripod with the microphone 4ft above floor level. It was regularly calibrated with an acoustic calibrator.

Since the sound level varied considerably over short periods of time in all the offices, the range of readings for an interval of approximately fifteen seconds was obtained for each octave band and weighting network, but noises which were unlikely to occur frequently were not included in the measurement.

In the smaller offices measurements were made near the centres of the rooms, ie, between four and six feet from the windows. In most of the larger offices preliminary readings showed that there was little variation in the range of noise levels in different parts of the offices and so readings were taken near the centre of the rooms. In some of the offices measurements were made with all the windows closed and then, if there were no objections from the occupants, with one window open.

Appendix 10.1
Supplement 7

THE UNIVERSITY OF LIVERPOOL

DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE : ROYal 6022 Ext. 353

15th October, 1962.

Dear Sir or Madam,

You will find, attached to this letter, a questionnaire in which you are invited to make a number of observations about your building. The questionnaire has been devised and circulated by members of the research staff of the University of Liverpool. In this, we are indebted to the management of the CIS and the Guild of Insurance Officials for their support and encouragement.

Through the medium of questionnaires and interviews, we hope to collect the sort of information that will be invaluable in the planning of work places. In this study we are concerned with the individuals' personal response to the conditions created by the architects, planners, and engineers.

The timing of this questionnaire was planned to coincide as closely as possible with the move into the new building. This is because the conditions in the previous buildings should still be fresh in peoples' minds, and they should therefore be able to make clearer comparative judgements. However, there are drawbacks in obtaining reactions at this stage. One of these is the time required by the engineers to master the heating and ventilating plant and to maintain the conditions that were planned. One cannot, of course, evaluate ultimate conditions until they have been attained, but much of value can be learned from the study of existing conditions. This creates the need for further research, and it is proposed to repeat some parts of this survey in 1963, after a suitable settling-in period.

I know that the questionnaire will require a good deal of time and thought to complete, but I hope that you will agree with me that the cause is worthwhile. Any large office building, built for perhaps a hundred years, will contain in its lifetime many thousands of people for much of theirs. It is therefore a matter of considerable practical importance to learn as much as possible about the effects on the individual of various working conditions.

All the information thus collected will be *completely confidential* to a small number of staff members in the university. No member of the CIS will have access to any of these documents. All replies will be quite anonymous, and the results dealt with in statistical terms.

I am sorry that it is not possible for me to talk to you personally, though I have talked to some people at the stage of drafting these questions, and look forward to seeing many more. I am hoping, however, that even in this short letter, I have been able to convey enough of the purpose and value of the research aims to encourage you to complete the questionnaire with care and judgement.

Yours faithfully,

Brian Wells.

Appendix 10.1
Supplement 8

Confidential

UNIVERSITY OF LIVERPOOL
Department of Building Science

Will you please answer each of the following questions by putting a tick in the brackets on the right hand side of the statement which is most nearly appropriate to your own case. ie, (✓) The figures to the right of the brackets eg 3:18, are merely the punching instructions for the statistical analysis so please ignore them.
Try to answer *every* question, and please don't discuss your answers with other people until the questionnaires are completed. With the best will in the world, it is hard to avoid influencing others, and the value of the entire project will depend upon getting as many independent assessments as possible.
When you have completed the questionnaire, would you please put it in the envelope provided and hand it to the Section or Chief Clerk in your Department sometime before Thursday.

1. Were you previously employed by the CIS in premises other than the present ones?

Yes ( ) No ( ) 1 : 11

If yes, at which of the following:—

1. 109, Corporation Street ( ) 1 : 0
2. 113-115, Portland Street ( ) 1 : 1
3. 117-119, Portland Street ( ) 1 : 2
4. 22, Long Millgate ( ) 1 : 3
5. Crown Buildings, 96 Dantzic Street ( ) 1 : 4
6. 77 Dantzic Street ( ) 1 : 5
7. 79 Dantzic Street ( ) 1 : 6
8. Trevalyan Buildings, 52 Corporation Street ( ) 1 : 7
9. New Elizabeth Street, Cheetham ( ) 1 : 8
10. Ormes Buildings, 14, The Parsonage ( ) 1 : 9
11. Other CIS Building (Please write)..
.... ( ) 1 : 01

2. On which floor do you now work?

Basement Document Store ( ) 25
Ground ( ) 00
1 ( ) 2 : 01
2 ( ) 2 : 02
3 ( ) 2 : 03
4 ( ) 2 : 04
5 ( ) 2 : 05
6 ( ) 2 : 06
7 ( ) 2 : 07
8 ( ) 2 : 08
9 ( ) 2 : 09
10 ( ) 2 : 10
11 ( ) 2 : 11
12 ( ) 2 : 12
13 ( ) 3 : 13
14 ( ) 3 : 14
15 ( ) 3 : 15
16 ( ) 3 : 16
17 ( ) 3 : 17
18 ( ) 3 : 18
19 ( ) 3 : 19
20 ( ) 3 : 20
21 ( ) 3 : 21
22 ( ) 3 : 22
23 ( ) 3 : 23
24 ( ) 3 : 24

3. Please turn to the back of this Questionnaire. You will find four floor-plans of this building printed on a single sheet of foolscap. Each individual will be concerned with only *one* of these diagrams, and this is the one for the floor on which you work.

When you have located the appropriate one, will you please mark with an 'X' the place where you normally work, or have your desk or machine. Please put only *one* 'X' on the plan. The small black squares on the plans represent the pillars inside the building. They should prove useful in fixing your position.

(Please note that Miller St is the street in which the main entrance is situated, and Dantzic St is the street that runs between this building and the new Conference Hall).

Appendix 10.1
Supplement 8

Confidential

UNIVERSITY OF LIVERPOOL
Department of Building Science

Will you please answer each of the following questions by putting a tick in the brackets on the right hand side of the statement which is most nearly appropriate to your own case. ie, (✓) The figures to the right of the brackets eg 3:18, are merely the punching instructions for the statistical analysis so please ignore them.
Try to answer *every* question, and please don't discuss your answers with other people until the questionnaires are completed. With the best will in the world, it is hard to avoid influencing others, and the value of the entire project will depend upon getting as many independent assessments as possible.
When you have completed the questionnaire, would you please put it in the envelope provided and hand it to the Section or Chief Clerk in your Department sometime before Thursday.

1. Were you previously employed by the CIS in premises other than the present ones?

Yes ( )   No ( ) 1 : 11

If yes, at which of the following:—

1. **109, Corporation Street ( ) 1 : 0**
2. **113-115, Portland Street ( ) 1 : 1**
3. **117-119, Portland Street ( ) 1 : 2**
4. **22, Long Millgate ( ) 1 : 3**
5. **Crown Buildings, 96 Dantzic Street ( ) 1 : 4**
6. **77 Dantzic Street ( ) 1 : 5**
7. **79 Dantzic Street ( ) 1 : 6**
8. **Trevalyan Buildings, 52 Corporation Street ( ) 1 : 7**
9. **New Elizabeth Street, Cheetham ( ) 1 : 8**
10. **Ormes Buildings, 14, The Parsonage ( ) 1 : 9**
11. **Other CIS Building (Please write)..**
    .. ( ) 1 : 01

---

2. On which floor do you now work?

Basement Document Store ( ) 25
Ground ( ) 00
1 ( ) 2 : 01
2 ( ) 2 : 02
3 ( ) 2 : 03
4 ( ) 2 : 04
5 ( ) 2 : 05
6 ( ) 2 : 06
7 ( ) 2 : 07
8 ( ) 2 : 08
9 ( ) 2 : 09
10 ( ) 2 : 10
11 ( ) 2 : 11
12 ( ) 2 : 12
13 ( ) 3 : 13
14 ( ) 3 : 14
15 ( ) 3 : 15
16 ( ) 3 : 16
17 ( ) 3 : 17
18 ( ) 3 : 18
19 ( ) 3 : 19
20 ( ) 3 : 20
21 ( ) 3 : 21
22 ( ) 3 : 22
23 ( ) 3 : 23
24 ( ) 3 : 24

---

3. Please turn to the back of this Questionnaire. You will find four floor-plans of this building printed on a single sheet of foolscap. Each individual will be concerned with only *one* of these diagrams, and this is the one for the floor on which you work.

When you have located the appropriate one, will you please mark with an 'X' the place where you normally work, or have your desk or machine. Please put only *one* 'X' on the plan. The small black squares on the plans represent the pillars inside the building. They should prove useful in fixing your position.

(Please note that Miller St is the street in which the main entrance is situated, and Dantzic St is the street that runs between this building and the new Conference Hall).

4. To which age group do you belong:
(Please place tick against appropriate group)

15 – 19	( ) 14 : 0	40 – 44	( ) 14 : 5
20 – 24	( ) 14 : 1	45 – 49	( ) 14 : 6
25 – 29	( ) 14 : 2	50 – 54	( ) 14 : 7
30 – 34	( ) 14 : 3	55 – 59	( ) 14 : 8
35 – 39	( ) 14 : 4	60 or more	( ) 14 : 9

5. What is your sex:

MALE	( ) 15 : 1

What is your rank or grade:

Basic 'A'	( ) 16 : 01
Basic 'B'	( ) 16 : 02
Grade 3	( ) 16 : 03
Grade 2	( ) 16 : 04
Grade 2a	( ) 16 : 05
Grade 1	( ) 16 : 06
Official	( ) 16 : 07
Other (Please write)	( ) 16 : 08

FEMALE	( ) 15 : 2

What is your rank or grade:

Basic 'A'	( ) 17 : 01
Basic 'B'	( ) 17 : 02
Basic 'C'	( ) 17 : 03
Machine punch operator	( ) 17 : 04
Other machine operator	( ) 17 : 05
Stencils group leader	( ) 17 : 06
Comptometer operator	( ) 17 : 07
Copy typist	( ) 17 : 08
Audio typist	( ) 17 : 09
Shorthand typist	( ) 17 : 10
Grade 2a	( ) 17 : 11
Grade 1	( ) 17 : 12
Other (Please write)	( ) 17 : 13

6. Do you feel that the lift service is:

Completely inadequate	( ) 18 : 1
Fair, but not quite adequate	( ) 18 : 2
Quite adequate	( ) 18 : 3

7. Do you feel that it is important to be able to see out of the office even if you have plenty of artificial light to work by?

Definitely yes	( ) 19 : 1
Moderately yes	( ) 19 : 2
Unimportant	( ) 19 : 3
Moderately not	( ) 19 : 4
Definitely not	( ) 19 : 5

8. Please place a tick beside any of the following words which you feel describes the colour scheme of your office:
(You may tick as many words as you feel appropriate)

Cold	( ) 20 : 1	Bright	( ) 21 : 1
Restful	( ) 20 : 2	Tasteful	( ) 21 : 2
Mediocre	( ) 20 : 3	Warm	( ) 21 : 3
Cheerful	( ) 20 : 4	Depressing	( ) 21 : 4
Beautiful	( ) 20 : 5	Glaring	( ) 21 : 5
Soothing	( ) 20 : 6	Dull	( ) 21 : 6
Ugly	( ) 20 : 7	Distracting	( ) 21 : 7

Others, please state ....
....

9. Do you ever feel uncomfortably cold whilst working?

Never	( ) 22 : 1
Sometimes	( ) 22 : 2
Often	( ) 22 : 3
Always	( ) 22 : 4

10. Do you feel that the height of the ceiling is:

Too high	( ) 23 : 1
About right	( ) 23 : 2
Too low	( ) 23 : 3

11. On balance, do you enjoy your work more or less, in the new surroundings?

Definitely more	( ) 24 : 1
Moderately more	( ) 24 : 2
No change	( ) 24 : 3
Moderately less	( ) 24 : 4
Definitely less	( ) 24 : 5

12. Does the air in the office normally seem fresh?

Yes ( ) 25 : 1
No ( ) 25 : 2

13. Do you ever feel uncomfortably hot whilst you are working?

Never ( ) 26 : 1
Sometimes ( ) 26 : 2
Often ( ) 26 : 3
Always ( ) 26 : 4

14. Do you feel that the amount of toilet accommodation is adequate?

Definitely inadequate ( ) 27 : 1
Somewhat inadequate ( ) 27 : 2
About right ( ) 27 : 3
Rather more than needed ( ) 27 : 4
Definitely more than needed ( ) 27 : 5

15. Please put a tick against any of the following which you feel might be improved. (You may tick as many as you like)

Colour scheme ( ) 28 : 11
Ventilation ( ) 28 : 0
Lighting ( ) 28 : 1
Lift service ( ) 28 : 2
Toilets ( ) 28 : 3
Heating ( ) 28 : 4
Canteen ( ) 28 : 5
Office furniture ( ) 28 : 6
Noise ( ) 28 : 7
Draught prevention ( ) 28 : 8
Space around desks ( ) 28 : 9

Anything else not listed above.. 29 :
....

16. Did you ever suffer from headaches in the premises you have just left?

Never ( ) 30 : 1
Seldom ( ) 30 : 2
Often ( ) 30 : 3

17. Do you ever suffer from headaches in this new building?

Never ( ) 31 : 1
Seldom ( ) 31 : 2
Often ( ) 31 : 3

18. Taking average conditions, do you find that the available daylight, together with the supplementary electric lighting is

Too bright for comfort ( ) 32 : 1
Comfortable ( ) 32 : 2
Too dull for comfort ( ) 32 : 3

19. In what sort of office would you prefer to work?

A large open one ( ) 33 : 1
A smaller partitioned area ( ) 33 : 2
No preference ( ) 33 : 3

20. In what way have your personal relationships with colleagues been affected by moving into the new building?

More friendly ( ) 34 : 1
Unaffected ( ) 34 : 2
Less friendly ( ) 34 : 3

21. Does the temperature of the office vary noticeably?

Never ( ) 35 : 1
Sometimes ( ) 35 : 2
Often ( ) 35 : 3
Regularly ( ) 35 : 4

22. Did you ever suffer from eye-strain in the premises you have just left?

Never ( ) 36 : 1
Seldom ( ) 36 : 2
Often ( ) 36 : 3

23. Do you ever suffer from eye-strain in this new building?

Never ( ) 37 : 1
Seldom ( ) 37 : 2
Often ( ) 37 : 3

24. How do you feel about working in a tall office block?

Very much like it	(	) 38 : 1
Moderate liking	(	) 38 : 2
No particular feeling	(	) 38 : 3
Moderate dislike	(	) 38 : 4
Very much dislike it	(	) 38 : 5

25. Tick any of the following words which you feel to be descriptive of your office (you may tick as many as you feel appropriate)

Friendly	(	) 39 : 0	Warm	(	) 40 : 0
Austere	(	) 39 : 1	Efficient	(	) 40 : 1
Comfortable	(	) 39 : 2	Unfriendly	(	) 40 : 2
Dark	(	) 39 : 3	Pleasant	(	) 40 : 3
Stimulating	(	) 39 : 4	Cold	(	) 40 : 4
Modern	(	) 39 : 5	Relaxing	(	) 40 : 5
Gloomy	(	) 39 : 6	Impersonal	(	) 40 : 6
Gay	(	) 39 : 7			
Stuffy	(	) 39 : 8			
Light	(	) 39 : 9			

Other(s) .... 41 :
....

26. Do you find that there are any unpleasant draughts where you work?

Never	(	) 42 : 1
Seldom	(	) 42 : 2
Frequently	(	) 42 : 3
Always	(	) 42 : 4

27. Comparing buildings, do you prefer working in this building or the one you have recently left?

Strongly prefer this	(	) 43 : 1
Moderately prefer this	(	) 43 : 2
No preference	(	) 43 : 3
Moderately prefer previous office	(	) 43 : 4
Strongly prefer previous office	(	) 43 : 5

28. Do you feel that it is as good for your eyes to work by artificial light as by daylight?

Definitely yes	(	) 44 : 1
Moderately yes	(	) 44 : 2
No difference	(	) 44 : 3
Moderately no	(	) 44 : 4
Definitely no	(	) 44 : 5

29. Do you ever find your workplace distractingly noisy?

Yes	(	) 45 : 1
No	(	) 45 : 2

If yes, is the source of the noise outside or inside the building?

Outside	(	) 46 : 1
Inside	(	) 46 : 2

If inside, please say what is especially distracting
.... 46 :

30. Do you like the new arrangement of working hours?

Definitely yes	(	) 47 : 1
Moderately yes	(	) 47 : 2
No preference	(	) 47 : 3
Moderately no	(	) 47 : 4
Definitely no	(	) 47 : 5

31. Is there ever an unpleasant amount of glare from the windows that you cannot personally control?

Yes	(	) 48 : 1
No	(	) 48 : 2

If yes, is this felt

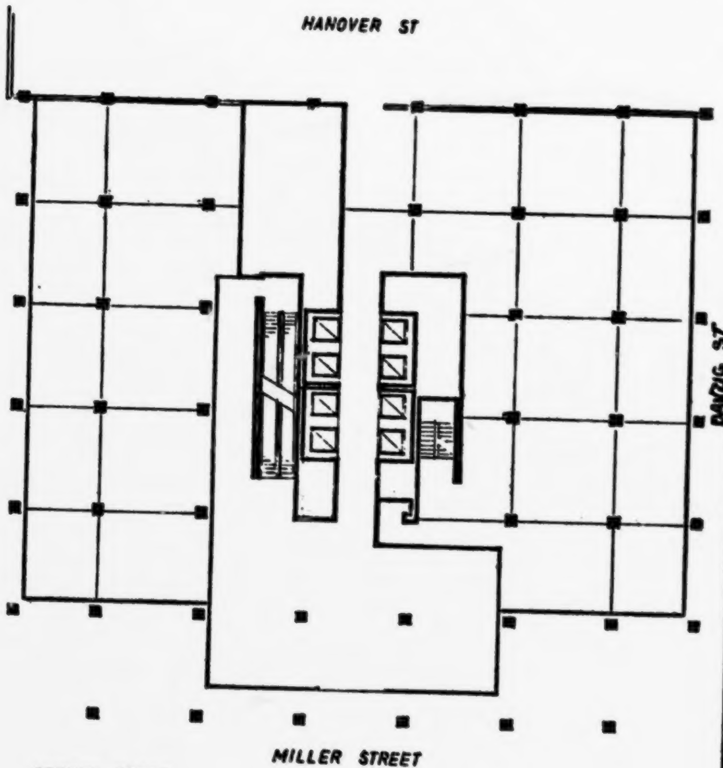
Seldom	(	) 49 : 1
Frequently	(	) 49 : 2
Most of the time	(	) 49 : 3

32. Are there any other observations about conditions in the new building which you would like to make, and for which scope has not been given in the questionnaire?
....
....
....
....

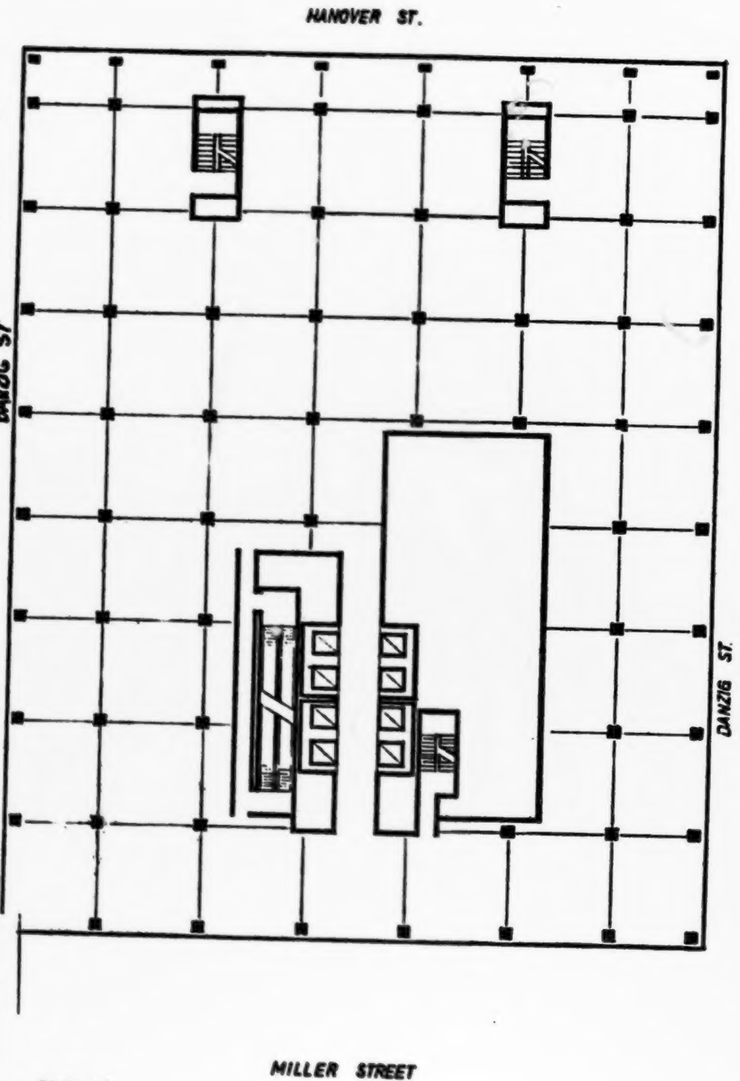
WE, FOR OUR PART, WOULD LIKE TO THANK YOU VERY MUCH FOR THE TIME AND EFFORT THAT YOU HAVE TAKEN IN FILLING IN THIS VERY COMPREHENSIVE QUESTIONNAIRE

Appendix 10.1
Supplement 9

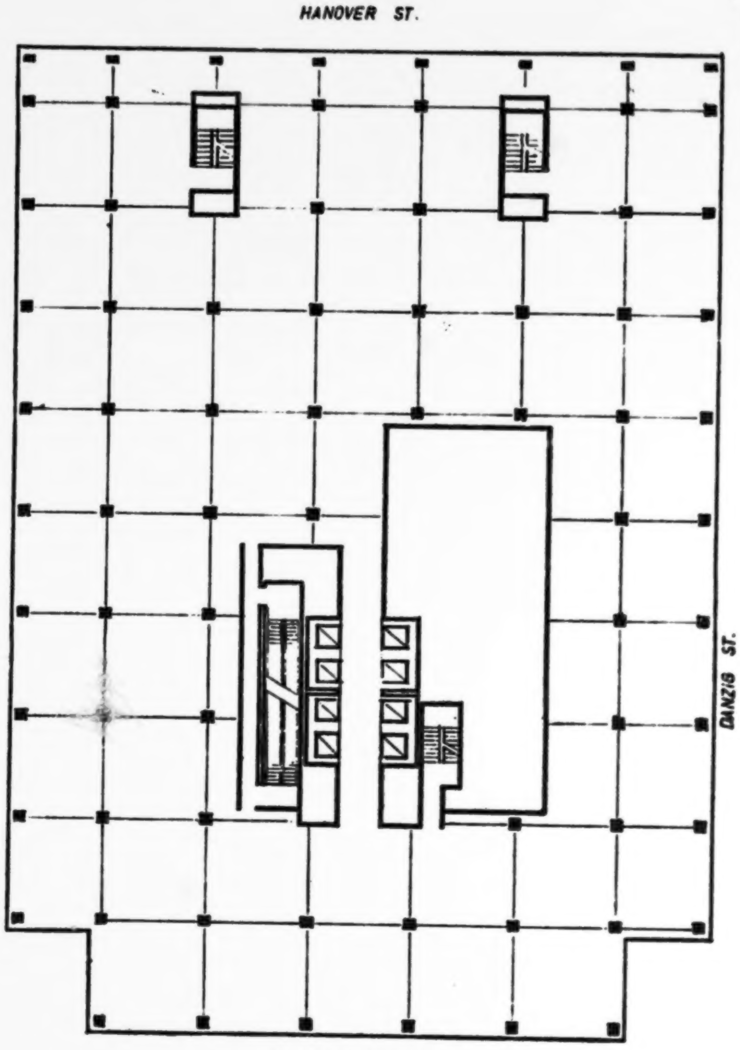
FLOOR PLANS OF BUILDING


HANOVER ST
DANZIG ST
MILLER STREET

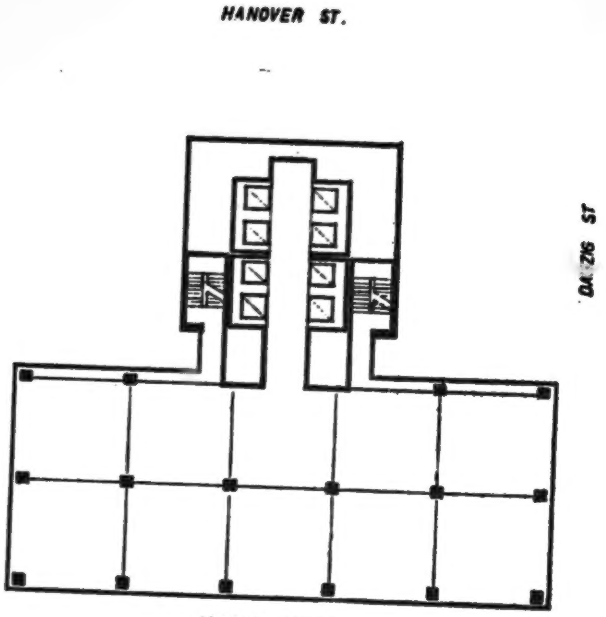
GROUND FLOOR


HANOVER ST.
DANZIG ST
MILLER STREET

FLOOR 1


HANOVER ST.
DANZIG ST.
MILLER STREET

FLOORS 2.3.4.


HANOVER ST.
DANZIG ST
MILLER STREET

FLOORS 5 — 24.

Appendix 10.2
Supplement 10

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE : ROYal 6022 Ext. 353

August, 1963.

Dear Sir or Madam,

As an extension of the questionnaires and physical measurements made since last October we are again looking in detail at the conditions for personal comfort as determined by environmental conditions.

We should therefore be grateful if you would complete the attached check-list some time during the morning. Instrument readings will also be made during the course of the day and I shall look forward to visiting you during the morning for more information.

It is only by virtue of the replies that we get to this questionnaire that we shall be able to know what standards to aim for. We therefore hope that you will be kind enough to consider your answers to the questions as carefully as possible.

Sincerely,

B. W. P. Wells

Appendix 10.2
Supplement 11

THE UNIVERSITY OF LIVERPOOL
DEPARTMENT OF BUILDING SCIENCE
THE UNIVERSITY, LIVERPOOL 3
TELEPHONE : ROYal 6022 Ext. 353

Confidential

Will you please answer each of the following questions by putting a tick in the brackets on the right hand side of the statement which is most nearly appropriate to your own case, ie, (✓). The figures to the right of the brackets, eg, 23 : 8, are merely the punching instructions for the statistical analysis so please ignore them.
Try to answer *every* question, and please don't discuss your answers with other people until the questionnaires are completed. With the best will in the world, it is hard to avoid influencing others, and the value of the entire project will depend upon getting as many independent assessments as possible.
When you have completed the questionnaire, would you please put it in the envelope provided and hand it to the Section or Chief Clerk in your Department sometime before lunch.

1. Floor................17 :

---

2. Position..

---

3. To which age group do you belong?
(Please place tick against appropriate group)

15 – 19	( )	22 : 0	40 – 44	( )	22 : 5
20 – 24	( )	22 : 1	45 – 49	( )	22 : 6
25 – 29	( )	22 : 2	50 – 54	( )	22 : 7
30 – 34	( )	22 : 3	55 – 59	( )	22 : 8
35 – 39	( )	22 : 4	60 or more	( )	22 : 9

---

4. What is your sex?

MALE (   ) 23 : 1
What is your rank or grade?

Basic 'A'	( )	24 : 1
Basic 'B'	( )	24 : 2
Grade 3	( )	24 : 3
Grade 2	( )	24 : 4
Grade 2a	( )	24 : 5
Grade 1	( )	24 : 6
Official	( )	24 : 7
Other (please write)	( )	24 : 8

FEMALE (   ) 23 : 2
What is your rank or grade?

Basic 'A'	( )	25 : 1
Basic 'B'	( )	25 : 2
Basic 'C'	( )	25 : 3
Machine punch operator	( )	25 : 4
Other machine operator	( )	25 : 6
Stencils group leader	( )	25 : 7
Comptometer operator	( )	25 : 8
Copy typist	( )	25 : 9
Audio typist	( )	26 : 1
Shorthand typist	( )	26 : 2
Grade 2a	( )	26 : 3
Grade 1	( )	26 : 4
Other (please write)	( )	26 : 5

5. Do you ever feel uncomfortably cold whilst working?

Never	( )	27 : 1
Sometimes	( )	27 : 2
Often	( )	27 : 3
Always	( )	27 : 4

6. Does the temperature of the office vary noticeably?

Never	( )	28 : 1
Sometimes	( )	28 : 2
Often	( )	28 : 3
Regularly	( )	28 : 4

7. Do you ever feel uncomfortably hot whilst working?

Never	( )	29 : 1
Sometimes	( )	29 : 2
Often	( )	29 : 3
Always	( )	29 : 4

8. Do you find that there are any unpleasant draughts where you work?

Never	( )	30 : 1
Seldom	( )	30 : 2
Frequently	( )	30 : 3
Always	( )	30 : 4

9. Does the air in the office normally seem fresh?

Yes	( )	31 : 1
No	( )	31 : 2

10. Do you ever suffer from headaches in this building?

Never	( )	32 : 1
Seldom	( )	32 : 2
Often	( )	32 : 3

11. Do you feel that the height of the ceiling is:

Too high	( )	33 : 1
About right	( )	33 : 2
Too low	( )	33 : 3

12. Taking average conditions, do you find that the available daylight, together with the supplementary electric lighting is:

Too bright for comfort	( )	34 : 1
Comfortable	( )	34 : 2
Too dull for comfort	( )	34 : 3

13. In what sort of office would you prefer to work?

A large open one	( )	35 : 1
A smaller partitioned area	( )	35 : 2
No preference	( )	35 : 3

14. Do you feel that it is as good for your eyes to work by artificial light as by daylight?

Definitely yes	( )	36 : 1
Moderately yes	( )	36 : 2
No difference	( )	36 : 3
Moderately no	( )	36 : 4
Definitely no	( )	36 : 5

15. Tick any of the following words which you feel to be descriptive of your office (you may tick as many as you feel appropriate).

Friendly	( )	37 : 1
Austere	( )	37 : 2
Comfortable	( )	37 : 3
Dark	( )	37 : 4
Stimulating	( )	37 : 5
Modern	( )	37 : 6
Gloomy	( )	37 : 8
Gay	( )	37 : 9
Stuffy	( )	38 : 1
Light	( )	38 : 2
Warm	( )	38 : 3
Efficient	( )	38 : 4
Unfriendly	( )	38 : 5
Pleasant	( )	38 : 6
Cold	( )	38 : 7
Relaxing	( )	38 : 8
Impersonal	( )	38 : 9

16. Do you feel that it is important to be able to see out of the office even if you have plenty of artificial light to work by?

Definitely yes	( )	39 : 1
Moderately yes	( )	39 : 2
Unimportant	( )	39 : 3
Moderately not	( )	39 : 4
Definitely not	( )	39 : 5

17. Is there ever an unpleasant amount of glare from the windows that you cannot personally control?

Yes ( ) 40 : 1
No ( ) 40 : 2

If yes, is this felt

Seldom ( ) 41 : 1
Frequently ( ) 41 : 2
Most of the time ( ) 41 : 3

---

18. Do you ever suffer from eye-strain in this building?

Never ( ) 42 : 1
Seldom ( ) 42 : 2
Often ( ) 42 : 3

---

19. Please place a tick beside any of the following words which you feel describes the colour scheme of your office: (You may tick as many as you feel appropriate)

Cold ( ) 44 : 1
Restful ( ) 44 : 2
Mediocre ( ) 44 : 3
Cheerful ( ) 44 : 4
Beautiful ( ) 44 : 5
Soothing ( ) 44 : 6
Ugly ( ) 44 : 7
Bright ( ) 44 : 8
Tasteful ( ) 44 : 9
Warm ( ) 45 : 1
Depressing ( ) 45 : 2
Glaring ( ) 45 : 3
Dull ( ) 45 : 4
Distracting ( ) 45 : 6

WE SHOULD LIKE TO THANK YOU VERY MUCH FOR YOUR KIND CO-OPERATION ONCE AGAIN AND TO ASSURE YOU THAT YOUR EFFORTS WILL BE EXTREMELY VALUABLE IN HELPING US TO ESTABLISH OPTIMUM WORKING CONDITIONS FOR CLERICAL OCCUPATIONS

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The design of roofs for single-storey general-purpose factories

A report upon an investigation

The Pilkington Research Unit's first report upon a building-type study described an investigation into the design of the most widely used industrial building and was published in 1962 under the title above.

The report was in five parts. In Part One the principal characteristics of existing British factories were examined, and the effects of current legislation upon design reviewed. The components of the total problem were considered singly in Part Two: thus the economic background to factory design was discussed, and separate chapters dealt with what was already known and what was discovered during the investigation about such structural matters as the building framework, structural fire protection and building maintenance, and such environmental factors as lighting, heating and ventilation. The neglected subject of thermal problems which arise during summer was considered. In Part Three an attempt was made to assess the total effect of the various structural and environmental components upon the economic choice of roof shape and structural module with particular emphasis on the choice between daylighted and 'windowless' factories. Current tendencies in the design of single-storey factories were reviewed in Part Four; matters considered included American and 'windowless' factories, and standardisation of factory structures. The conclusions to be drawn from the whole report were summarized in Part Five. The report contained extensive references to the existing literature, and a series of appendices concerned with the research methodology.

The report is now out of print.